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MAY'S ANATOMY PHYSIOLOGY AND HYGIENE

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BY

GOOLD BROWN.

TENTH EDITION—REVISED AND IMPROVED.

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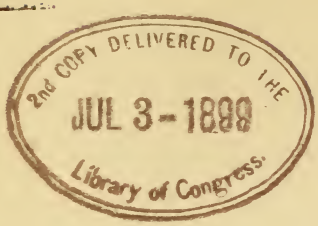

MAY'S

ANATOMY, PHYSIOLOGY

AND

HYGIENE

FOR USE IN PRIMARY AND INTERMEDIATE SCHOOLS

FOURTH EDITION

REVISED BY

SMITH ELY JELLIFFE, M.D.

WILLIAM WOOD AND COMPANY
NEW YORK

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ENDORSEMENT.

We, the undersigned, have carefully examined the school text-book on physiology entitled May's Anatomy, Physiology, and Hygiene, and, believing it to accord with the ascertained truths of science relating to the nature and effects of alcoholic drinks and other narcotics, we cheerfully endorse it for the use of pupils of advanced grammar-school grade.

Mary H. Hunt,
National Superintendent, Department of Scientific Temperance Instruction of the Woman's Christian Temperance Union.

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PREFACE.

In the following pages the author has endeavored to present, in as simple and clear a manner as possible, the most important facts relating to the anatomy, physiology, and hygiene of the human body.

Of late years physicians have laid great stress upon the study of the prevention of disease ; and, keeping pace with this improvement, the laity have become better informed about matters pertaining to the care of the body than formerly. The great utility of such knowledge has led to the enactment of laws in New York and other States making provision for the study of physiology and hygiene in the public schools, with special reference to the effects of stimulants and narcotics upon the human system. Such legislative provisions are very gratifying. Proper instruction to children on these subjects must do much to diminish the amount of sickness and raise the general standard of health.

The author has endeavored to use the simplest terms compatible with clearness.

The lessons will be made more interesting and valuable if illustrated by the various tissues obtainable at the butchers'; thus, the heart of a calf will serve nicely to show the general shape and arrangement of cavities and valves in the human heart. In the same way other organs and tissues should be

utilized by the teacher to elucidate the various parts of the body. The skeleton and its different parts should be before the class in reciting upon the bones.

The synopsis given at the end of each chapter is intended to be of use in reviews and in guiding the teacher in a systematic presentation of the subject.

FOURTH EDITION.

In this edition the author has made a number of changes. The chapters on Alcoholic Drinks and Narcotics have been entirely rewritten, a new chapter on Physical Exercise introduced, and the whole work been remodelled.

S. E. J.

231 West Seventy-First Street,
New York.

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CHAPTER I.

INTRODUCTION.

THERE is a beautiful allegory upon human life, by Addison, called "The Vision of Mirzah." Mirzah, who had ascended the hills of Bagdad to spend a day in quiet meditation, says, "And behold as I sat there, I heard a sound as of sweet music, and looking up I saw a genius clad in shepherd's garments, who beckoned me and said, 'I have heard thy musings on the life of man,' and he commanded me to look eastward. I did so and beheld a great valley with a foaming tide rushing through it. Spanning it was a bridge, composed of three-score-and-ten arches, which, added to some broken ones near one end, made up the number to nearly one hundred. At either end was a thick mist. I turned to the genius in surprise. 'What does this mean?' I asked.

"Then he told me that the mist was the mist of eternity, and the bridge, the bridge of life. And as I looked I noticed many people passing over it, and also that there were numerous trap-doors in the bridge, more numerous at the ends than in the middle, which opened as they were stepped upon, and let the people fall through into the rushing tide beneath, which bore them quickly away into the mist. I noticed some of the people pushing others on trap-doors that they otherwise would not have trodden on, and also that many others were busy in the pursuit of bubbles which broke almost as soon as they grasped them. I noticed that very few got past the middle part of the bridge, though some did keep up a kind of hobbling march through the broken arches, though they looked tired and weary from the long walk."

This allegory is unfortunately true, and few people who are born into the world live past middle life, and such are apt to be less strong and well than in youth. Very many die when they are little children of diseases or accidents which are the trap-doors of the vision. Others are "pushed through," which means that they are killed in battle or starved by the greediness of others, or that they are led by their companions on the dangerous trap-door of drink, which every year opens for more people to drop through than are killed in all the battles all over the world.

The bubbles which many chase are riches and pleasure. But if one has not health to enjoy them they are of no value. In olden times people were always seeking for the Elixir of Life, which would make them live forever. They never found it. But to-day wise men realize that the nearest thing to the Elixir is knowledge—knowledge of how to make our bodies large and strong, how to prevent sickness, and how to live as long as possible.

We look with wonder upon some of the machines made by men, the steam-engine, the printing-press, or the telephone; but the human body, with its power to move, to talk, to see, to hear, and to think, is far more complicated and wonderful than any machine; and it requires something more than ordinary intelligence to keep it in perfect running order.

Pain is the signal to us that we must stop for repairs, but it is a poor engineer who waits until his engine breaks down before he puts it in order; so it is an unwise man who overworks or over-indulges himself until sickness tells him he must stop. There is always some one part of the body that will give out first. One may have inherited some weakness of heart or lungs; another may have from childhood overtaxed his stomach by rapid eating, while a third may have injured his eyes by late reading, and so toward middle life something begins to wear out, and coughs, indigestion, or headache give warning of danger. It is therefore well worth

our while to learn how each of us can develop our bodies to their fullest possibility of physical and mental culture.

There can be no study more fascinating than the study of our bodies. We listen to the music of an organ that is made by blowing wind through long pipes, but we have in our own throats the "organ" of speech which can make far more beautiful music, and a pair of lungs which act as bellows and which work of themselves day and night. What do they look like?

We marvel that the fine hair-spring of a watch can keep it ticking for twenty-four hours, and yet we have a heart that will keep on beating for seventy years without winding up. How does it do it?

But the most wonderful thing about man is his mind, which in some mysterious way is connected with the soft gray brain inside his skull. With his mind he studies, he calculates, he loves, he does business, he plans for the future; and yet if he treats his brain badly, as by exciting it with strong drink, the clear mind is lost and the man becomes like a beast of the field. What can one do to prevent this?

The three combined studies of **Anatomy, Physiology, Hygiene,** will teach us everything we want to know about our bodies.

Anatomy is the study of the form and structure of the different parts of the body. It teaches us the size and shape of the bones, the kinds of muscles that move them, as well as the shape and position of the various **Organs** of the body. An **Organ** is some part, like the heart or stomach, which has some special work to do. This work is called its **Function.**

Physiology is the study of how we live. It explains how the lungs breathe, how the blood circulates, and how the stomach digests its food; in short, what is the special function of each organ.

Hygiene, so-called after Hygeia, the goddess of health, is the science that teaches us how to keep all the organs of the

body performing their functions; in other words, how to keep well.

Before we begin to study our bodies let us see where we stand in the universe. Man is called the lord of creation, because he is the noblest work of the Creator ; he is the highest of all animals, and yet he is very closely related to some of the lowest forms of life, and is wholly dependent on all the animal and vegetable life around him.

For instance, there is a little animal, so small that it cannot be seen without a microscope. It is called Amœba. It lives in stagnant water, and sometimes strays into our drinking-water, without doing it any harm. This amœba is a soft, shapeless mass of pulp, called protoplasm, without any skin to hold it in shape. It is the lowest kind of animal that lives; it has no mouth, no stomach ; it simply absorbs water, and rolls itself around little particles of food. It can divide in half and become two amœbæ. The amœba and man stand at the opposite extremes of the animal kingdom, and yet man has in his body countless cells that look and act almost exactly like the amœba. In fact, man is largely made of different kinds of minute cells.

A cell is a bit of protoplasm surrounded by a covering or wall, and containing a body in the middle which is called the nucleus. Every living cell has, or has had the power to divide and make two new cells. This is the secret of life. It is the cause of all growth in animals and plants, and the thing that makes them different from the stones and water of the mineral kingdom.

To get the idea of a cell, think of a grape, with its soft pulp, like protoplasm ; its thin skin, like the wall, and its cluster of stones in the centre, like the nucleus. There are many kinds of cells in the body, some are long fibres, like threads, such as the nerves ; others are flat, like scales, as in the skin. The cells in the bones have hard walls, and those of the blood, which are called corpuscles, are like the amœba, without any

walls at all. Each cell has its own term of life, and its own duties; those in the liver secrete bile, those in the muscles produce motion. As soon as they have lived their day, they are seized upon as waste matter, and hurried away and cast out of the body, while new ones are formed to take their places.

Thus we see that the health of our bodies depends on the nourishment and health of each separate cell. If we burn our hands some of the cells are destroyed, and those lying near go to work to form new cellular tissue to take their place. If we eat too much candy the liver becomes overloaded with sweet and does not properly purify the blood, and the impurities work through the skin in the form of blotches and pimples.

The cells of the body are constantly demanding food, but all they want is a few mineral substances such as salt and lime to make the bones hard, iron to give vigor to the blood, and four elements, Carbon, Hydrogen, Oxygen, and Nitrogen. **Carbon** is like the soot that a flame gives off. **Oxygen** is that part of the air that gives us life. **Hydrogen** and **Oxygen** together make water, and **Nitrogen** is the gas that dilutes the Oxygen in the air. If we were the only living things in the universe we could not get at these foods, for our bodies are not made to take them in their pure form.

Plants, however, can absorb them from the water and air and soil; they turn them into starch and sugar and other foods and store them up in their cells. Animals eat the plants, and make these four elements over into fat and muscle. When we eat vegetables and meat we are giving our cells the same Carbon, Oxygen, Hydrogen, and Nitrogen that has been worked over into food for the plants and animals.

But not all plants or animals are helpful to man. The savages fear wild animals and certain plants, with which their enemies poison their arrow-tips, so that a dart causes death; but civilized man has discovered in the last fifty years a class

of very minute plants and animals, which are the cause of a great many diseases, as well as of much benefit to man.

These are generally called **germs,** though the term **bacteria** may be applied to most of them. The **bacteria** are infinitesimal one-celled plants that divide to form new ones, and that increase by the thousands and millions. There are as many kinds as there is variety in the results they produce. One kind, growing in cheese, gives it its flavor; another kind growing in milk makes it sour. Some grow on meat and cause it to decay. Some grow in our bodies, when they can find a lodgement, and make us ill. Diphtheria, consumption, cholera, and many other diseases are caused by bacteria which attack the cells and infuse poisons into the blood.

The life of man is thus an endless struggle of cells against cells. If the cells that make up his body get sufficient food so that they can grow and form new ones, then his body grows and thrives; but if they do not get enough food, many of them perish, and his body becomes pale and thin and sick.

In the study of Anatomy, Physiology, and Hygiene, there will be many technical names to remember, and many scientific facts to learn; but the successful students will not be those who merely get high per cents in their recitations, but those who by learning to take care of their bodies are able to walk with firm steps over many arches of the bridge of life.

SUBDIVISION OF THE BODY.

We may divide the body in many different ways:

(1.) Into different *parts* of the body; such as the head, the trunk, the limbs. These again may be subdivided.

(2.) We may further divide these into the different *tissues.* A *tissue* is one of the simple forms of material of which the different parts of the body are composed; thus, the finger consists of bone, fat, muscle, arteries, veins, nerves, skin—all these are tissues.

(3.) If we subdivide still further, and again and again,

until we come to the very smallest part, we have the *cell*, the *fibre*, and a *substance between these*, which may be jelly-like or may be hard. The entire body is formed of millions of these cells and fibres and this substance between them. They are all very small and we must use a strong microscope to see them. It is only when millions of them are gathered together that they form a mass large enough to be seen with the unaided eye. The *cells* are of different shapes, but usually they are more or less rounded. The *fibres* are thread-like.

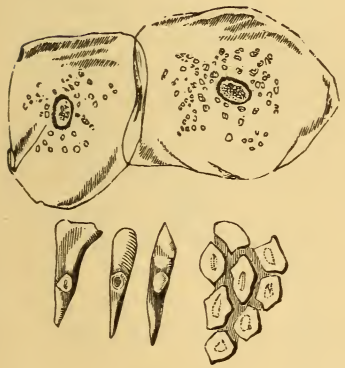


Fig. 1.—Some Different Forms of Cells.

Fig. 2.—A Collection of Fibres, Separated.

PARTS OF THE BODY.

The human body can be divided into:

(1.) The head and neck.

(2.) The trunk.

(3.) The limbs.

The Head and Neck.—The head has a large *cavity for the brain*, and *smaller ones* to receive the *eyes*, *ears*, *nose*, and *tongue*. It is divided into the *crown* (the top part), and the *face*.

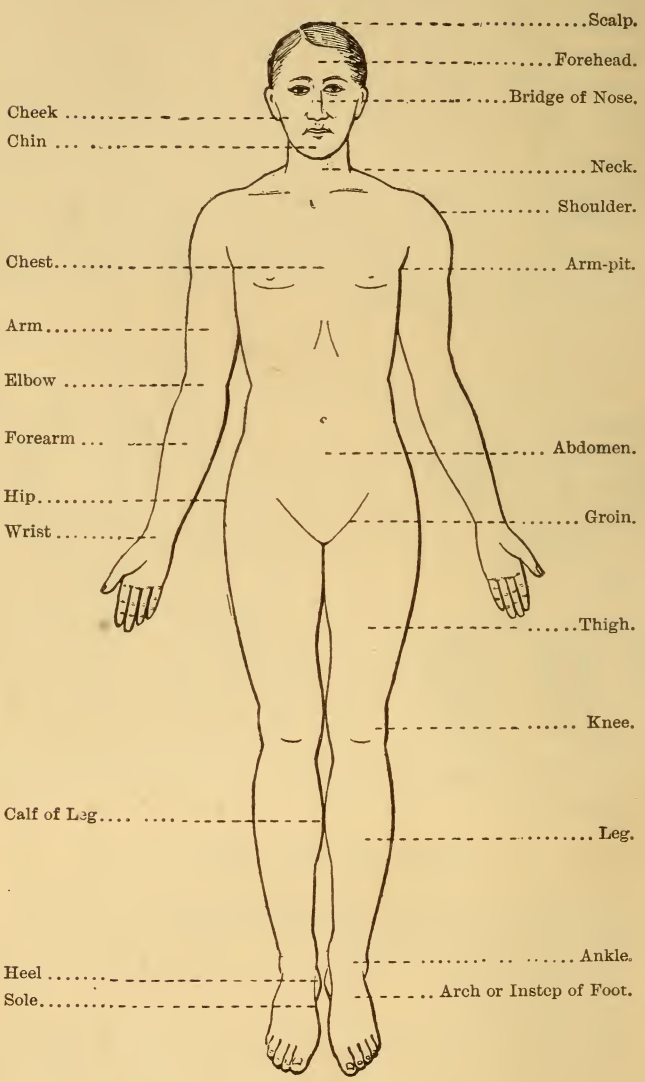


FIG. 3.—The Names of the Different Parts of the Body.

The Trunk is the part of the body between the neck and upper limbs above, and the lower limbs below. It has *two large cavities:* an upper one, called the *chest* or *thorax*, for the heart and lungs ; and a lower one, called the *abdomen*, for the organs of digestion.

The Limbs are attached to the trunk.

SYNOPSIS.

The vision of Mirzah and its meaning.
Wonderful mechanism of the body and its care.
Relation of man to the lower animals and to plants.
Definition and description of cells.
Food for the cells of our bodies contain same elements as food of plants and animals.
Struggle of the cells of our bodies against the germs of disease.
Organ—A part which performs some special work.
Function—The special work which an organ does.
Subdivisions of the body :

a. Structure—Tissues, simple forms of material :
1. Cell. 2. Fibre cells. 3. Substance between.

b. Parts :
1. Head and neck.
   a. Crown. *b.* Face.
2. Trunk.
   a. Thorax. *b.* Abdomen.
3. Upper limb.
   a. Arm. *b.* Forearm. *c.* Hand.
4. Lower limb.
   a. Thigh. *b.* Leg. *c.* Foot.

QUESTIONS.

1. What was the Vision which Mirzah saw? and explain its meaning. 2. Why do few people live past middle life? 3. What does pain do for us? 4. What are Anatomy, Physiology, and Hygiene? 5. Where does man stand in the Universe? 6. Describe the lowest animal, the Amœba. 7. What is a cell, and what do some cells look like? 8. What relation do cells bear to our bodies? 9. What are the four elements that cells need for food? 10. What are Carbon, Hydrogen, Oxygen, and Nitrogen? 11. How do plants get their food? 12. How do animals get their food? 13. How does man get his? 14. How do some bacteria hurt the cells of our bodies? 15. Name the three main parts of the body. 16. Into what parts can the head be divided? 17. What is the trunk and what large cavities does it contain?

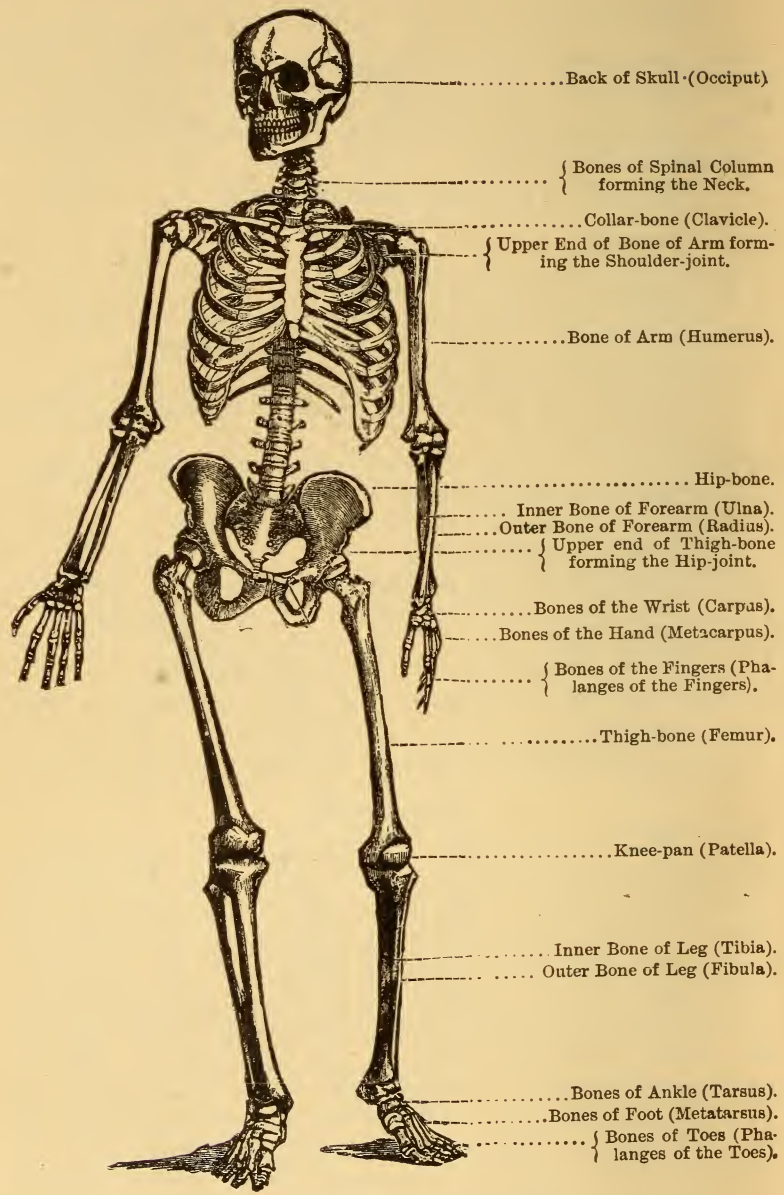

Back of Skull (Occiput)
Bones of Spinal Column forming the Neck.
Collar-bone (Clavicle).
Upper End of Bone of Arm forming the Shoulder-joint.
Bone of Arm (Humerus).
Hip-bone.
Inner Bone of Forearm (Ulna).
Outer Bone of Forearm (Radius).
Upper end of Thigh-bone forming the Hip-joint.
Bones of the Wrist (Carpus).
Bones of the Hand (Metacarpus).
Bones of the Fingers (Phalanges of the Fingers).
Thigh-bone (Femur).
Knee-pan (Patella).
Inner Bone of Leg (Tibia).
Outer Bone of Leg (Fibula).
Bones of Ankle (Tarsus).
Bones of Foot (Metatarsus).
Bones of Toes (Phalanges of the Toes).

FIG. 4.—The Skeleton, Viewed in Front.

CHAPTER II.

THE FRAMEWORK OR SKELETON.

The Skeleton.—This is the name given to the bony framework inside our bodies. Most animals have some kind of support for the soft flesh and internal organs which otherwise would be crushed. If you boil a fish until the meat can easily be picked off, you will find its skeleton inside. It consists chiefly of a long backbone with spines, and a very small skull. If you boil all the bones of a chicken until they are quite clean you can reconstruct its skeleton by fastening the bones with fine wires at the joints where in life they were bound together by cartilage.

Animals that cannot move at all, like clams and oysters, or those that move very slowly, as snails and lobsters and crabs, have their skeletons on the outside. They are then called shells. The turtle has a skeleton of little bones inside its body, and a strong horny shell outside to protect it from accident, for it cannot move out of harm's way as quickly as a frog or mouse or bird.

The skeleton of a man is very much like the skeleton of the higher apes, except that the back bone, or spinal column, is erect, the forearms are shorter and not so thick, and the skull is larger.

The word "skeleton" means "a dried-up body." We generally apply the word to all the dead bones of the body, after they have been cleaned and fastened into their places with wire.

The power of bone to resist decay is remarkable. Fossil bones deposited in the ground long before the appearance of man upon the earth have been found to exhibit a considerable portion of cartilage. The jaw of the Cambridge Masto-

don contained over forty per cent. of animal matter—enough to make a good glue—and others about the same. The teeth resemble bone in their structure, but resist decay longer; they are brought up by deep-sea dredging when all other parts of the animal have wasted away.

Bone is said to be twice as strong as oak, and to crush a cubic inch of it, a pressure equal to 5,000 pounds is requisite.

Uses of Bones.—The uses of bones are :—

(1.) To give *support* to the flesh and to *hold* the body *erect.* A few people have been born with soft bones that did not become any harder as they grew older. They were consequently never able to sit up or to walk. Man is the only animal that can stand upright. This is due to the position and shape of his spinal column, which has three slight graceful curves, and which holds the head up instead of letting it hang down as in all the lower animals.

(2.) To *protect* soft parts which would otherwise be easily injured. The heart and lungs are held inside of a strong, springy framework, made by the ribs and the breastbone. The brain, which is very soft and delicate, is completely covered by a strong bony box called the skull. If the skull is broken open by accident, and the brain injured, the person generally dies. Therefore it is necessary that the skull should be so hard that a severe blow will not fracture it. A man's brain is larger for his size than the brain of any other animal, therefore the skull that covers it is proportionally larger.

(3.) To give great *strength* and *hardness,* and at the same time leave the part *elastic,* as in the wrist and foot. In the foot, for instance, there are many small bones joined together in such a way that, though they are strong enough to bear the weight of the body, they are still elastic enough to allow us to jump upon the foot without injury.

(4.) Lastly, bones are necessary for the purpose of *motion ;* for walking and running, for grasping objects, and

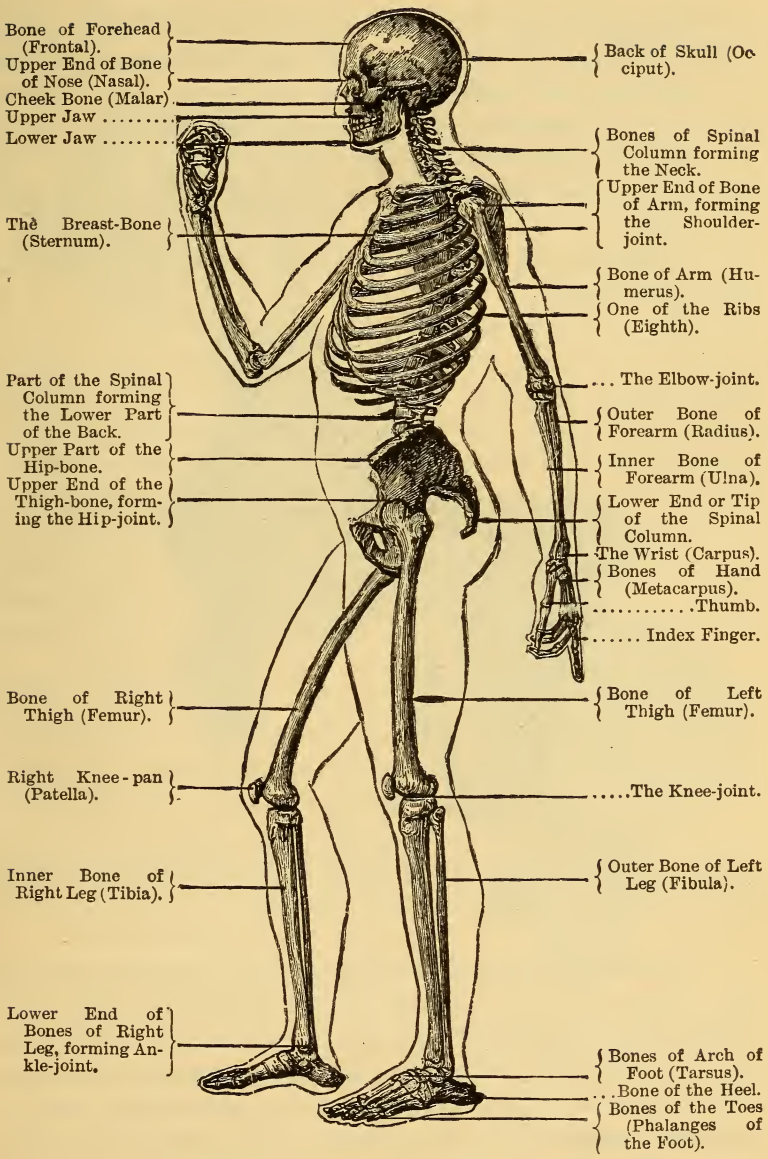

Bone of Forehead (Frontal).
Upper End of Bone of Nose (Nasal).
Cheek Bone (Malar).
Upper Jaw
Lower Jaw
The Breast-Bone (Sternum).
Part of the Spinal Column forming the Lower Part of the Back.
Upper Part of the Hip-bone.
Upper End of the Thigh-bone, forming the Hip-joint.
Bone of Right Thigh (Femur).
Right Knee-pan (Patella).
Inner Bone of Right Leg (Tibia).
Lower End of Bones of Right Leg, forming Ankle-joint.
Back of Skull (Occiput).
Bones of Spinal Column forming the Neck.
Upper End of Bone of Arm, forming the Shoulder-joint.
Bone of Arm (Humerus).
One of the Ribs (Eighth).
The Elbow-joint.
Outer Bone of Forearm (Radius).
Inner Bone of Forearm (Ulna).
Lower End or Tip of the Spinal Column.
The Wrist (Carpus).
Bones of Hand (Metacarpus).
Thumb.
Index Finger.
Bone of Left Thigh (Femur).
The Knee-joint.
Outer Bone of Left Leg (Fibula).
Bones of Arch of Foot (Tarsus).
Bone of the Heel.
Bones of the Toes (Phalanges of the Foot).

FIG. 5.—The Skeleton, Viewed from the Side, with Outline of the Body.

for performing the many actions required of us. The thigh-bones and the bones of the leg, for instance, are necessary for walking. Bones serve as points of attachment for muscles, and are moved through the action of these muscles; they simply carry out the will of the muscles, and these again are directed by our nerves and brain.

Number of Bones.—There are *two hundred* bones in the human body.

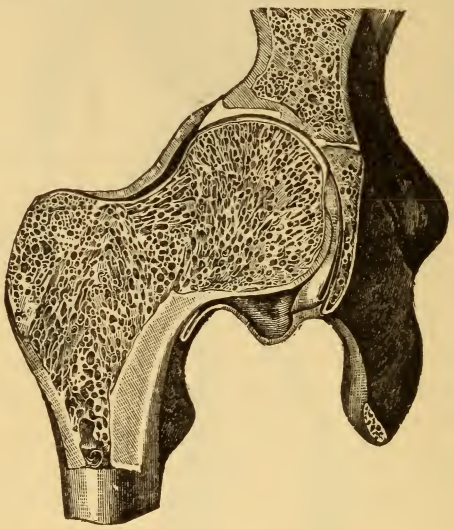


FIG. 6.—The Upper End of the Thigh-bone, where it Forms Part of the Hip-joint, Sawed through Lengthwise, Showing the Porous and Spongy Nature of Bone in Its Interior, and also the Commencement of the Central Canal for the Marrow.

Forms of Bones.—Bones vary very much in form and size. Some of them are *long*, as the thigh-bones (Fig. 21); others are small and *short*, such as the eight bones which form the wrist (Fig. 20); others are *flat*, as for example the bones forming the skull (Fig. 11); finally others are of very odd and *irregular* forms, such as the bones which form the spinal column (Fig. 16).

Structure of Bone.—Each bone is surrounded by a very hard layer on the outside, within which the bone is looser and porous, having a large number of small spaces through which the blood-vessels run (Fig. 7). The long bones, as those of the arm, thigh, and fingers, are hollowed out in the centre, and in this canal we find a fatty substance called *marrow*. This hollowing out of the bone makes it lighter and also stronger than it would otherwise be. Bones are closely covered by a tough membrane called the *periosteum*, which gives additional strength and protection to them. They are of a pinkish color during life, on account of the small blood-vessels running through them; when dead, the color of bone changes to white.

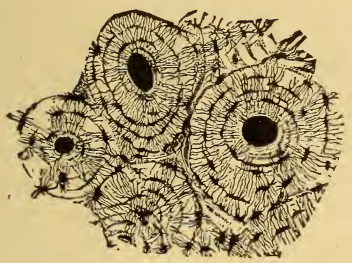


FIG. 7.—A Thin Slice of Bone, Cut Crosswise, as Seen under the Microscope.

If we take a thin slice of bone, and look at it under the microscope, we shall see a large number of dark spots, with small lines running from them (Fig. 7). They correspond to the minute spaces which exist even in the densest bone, and show that it is never entirely solid.

Composition of Bone.—Bone is composed of two parts of a hard mineral substance containing a great deal of lime, and of one part of a soft material like *gelatin*. The mineral substance gives the bone its hardness; the soft material makes it tough and elastic. To prove this we have only to dissolve out the mineral substance by a weak acid, and we

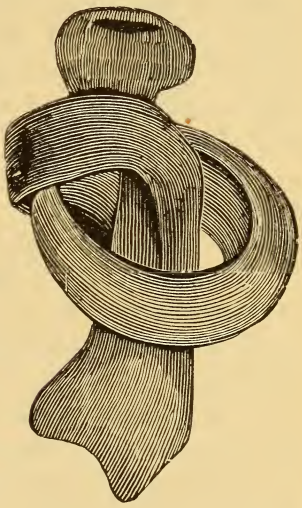


FIG. 8.—The Outer Bone of the Leg, Tied into a Knot after the Hard Mineral Matter has been Dissolved out by Acid.

find that we can now bend the bone in any direction because it has lost its hardness; if it be long enough, we can even tie it in a knot without breaking it, as is shown in Fig. 8.

If, on the other hand, we put the bone into the fire, the gelatine will be driven off, and then the bone will have the same form as before, but will be very brittle and crumble very easily.

In the baby, the bones consist very largely of a soft material, called *cartilage*. This is the reason why the baby cannot stand, or, if it is allowed to stand too soon, the bones of the legs may become bent, because they are not yet hard enough to bear the weight of the body. Gradually, as the baby grows, the hard matter is added. In young persons the bones are always softer than in the aged, and therefore do not break so easily. In old persons there is less gelatine and a larger proportion of the brittle mineral substance than in youth; hence their bones are more brittle and are more easily broken, or, as the surgeons would say, are more liable to *fracture*.

Care of the Skeleton.—If we wish to have erect and graceful bodies when we grow up, we must take care of them while we are young. It is while we are young that the bones are still soft and easily shaped. We should always remember to *stand and sit erect*, with the chest thrown forward and the shoulders back; in this way we may avoid stooping and round shoulders.

We should not wear any clothing which is *too tight*. How often do we see misshapen chests in girls because they have worn dresses which were too tight. Fig. 72 is the picture of a chest which has become deformed through *tight dressing*. If we compare it with Fig. 18, which represents a healthy chest, we cannot fail to notice the difference.

We must be careful to get *shoes of proper size;* for if they are too small or too pointed our feet will become deformed, our toes bent and crooked, and painful corns and bunions will

result. Such deformities are shown in Fig. 10. Girls should not be allowed to wear high heels, as they crowd the foot into the front part of the shoe, thus making the toes overlap. Shoes with high heels do not support the weight of the body properly, because they throw the upper part of the body forward. Another objection to high heels is the danger of accidents from falling and of spraining the ankle.

Fracture of a Bone.—When a bone is broken the accident is quite serious, and is called a *fracture.* The doctor is called and he *sets* the bone, that is, he brings the two broken

FIG. 9.—A Natural Foot.

FIG. 10.—A Foot which has Become Deformed and Affected with Corns and Bunions as a Result of Tight and Ill-fitting Shoes.

ends of the bone together, and keeps them in position by bandaging them to a piece of thin board so that they cannot be moved; then a soft material is formed between the two pieces, which gradually hardens and joins the two ends together. If properly taken care of, a broken bone becomes united again in several weeks, and is then as strong as it was before. If we happen to break a bone we must remember to keep as quiet as possible until the doctor arrives, so as not to move the injured part, and thus make matters much worse.

Effect of Alcohol upon the Bones.—The bones do not stop growing until one is twenty-five years of age. It is

therefore important that they should have plenty of good blood to nourish them. As the blood flows through the little cavities, in and out of the fine network and marrow, the bones have the power to take from it what they need and turn it into new bone. But from alcohol they can get no bone-making material. The foods that bones need to make the mineral substance hard and strong, are phosphates, such as are found in fish, oatmeal and brown bread, and to make the gelatine part grow in a healthy way, such food as is found in beef and mutton. But a person who drinks alcoholic liquors may lose his natural taste for such nourishing food; then the bones do not get all they need for their growth. If children or young people are given such drinks they are liable to remain small and undeveloped, instead of becoming strong, finely built men and women. Children who are underfed and overworked never grow very tall or large, because their bones are starved; but often the sons of wealthy men are no better in their physical appearance than the sons of the very poor, for the use of alcoholic drinks has prevented their bones from growing.

The bones of drunkards break more easily than the bones of temperate people, because they are poor in quality and brittle. And when they are set the thin alcohol-poisoned blood that flows through them, does not form enough of the substance that knits them together. Therefore the broken arm or leg which quickly unites in a young person of regular habits, becomes a very serious thing in a man who is in the habit of taking strong drink. And if the break be a compound fracture—that is, a break of the bone together with an open wound in the flesh—it is almost impossible to prevent blood-poisoning from setting in, in which case the man may die.

Effect of Tobacco upon the Bones.—It is but seldom one finds a tall, finely built man who has smoked habitually since he was a young boy. Nearly all boy smokers grow to be short, stunted men. The reason for this is that

tobacco contains a poison called nicotine, which has a very bad effect on the blood. In addition to impoverishing the blood, smoking takes away the appetite, and the bones suffer with the rest of the body for lack of food. It is no use to try to make one's self taller after the bones have stopped growing. The Scripture says: "No man by taking thought can add one cubit to his stature." But any boy by using *forethought* and common sense can grow to the fullest possibility of his own individual body, and it is not an exaggeration to say that a boy who smokes cigarettes is deliberately throwing away several inches of his manhood's height.

THE DIFFERENT PARTS OF THE SKELETON.

We may divide the skeleton into four parts :—

(1.) Bones of the head.
(2.) Bones of the trunk.
(3.) Bones of the upper limbs.
(4.) Bones of the lower limbs.

Bones of the Head.—The bones of the head taken together form the *skull* (Figs. 11, 12, and 13). The skull is made up of twenty-two bones. Eight of these are joined together at the upper and back part, forming an oval box of bone in which the brain is contained, and called the *cranium.* The front part of the skull, formed by the remaining fourteen bones, is called the *face.*

The Cranium.—The portion of the cranium which forms the forehead is called the *frontal* bone (1, Fig. 13). In the lower animals, such as the dog and the cat, the forehead is very low and slanting ; in the negro race it is less slanting ; while in the white races it is almost upright. Usually the prominence of the forehead indicates the development of the brain ; and in those who have spent much time in study it is usually very prominent. Behind, the cranium is formed by the *occipital* bone (3, Fig. 13). Above, two bones, known as the *parietal* (2, Fig. 13), join together to form the top of the skull.

On the side of the head, just below where the hair ends, is a spot called the *temple*; the bone which forms this part of the skull is called the *temporal* bone (4, Fig. 13).

Most of the bones of the cranium have *ragged edges* looking like the teeth of a saw (Figs. 12 and 13), and when the bones are joined these teeth fasten the bones together just as if you spread out the fingers of one hand and then put them in the

Fig. 11.—The Skull, Front View.

spaces between the fingers of the other. In this way the bones are firmly united, and yet there is space between the edges so that they can give a little. This space is very important, for if these bones could not give at all, every blow upon the head would injure the soft, delicate brain within. The muscles, skin, and hair on the head also serve to break the force of blows.

The Face.—Looking at the skull in front (Fig. 11) we see two large openings just below the forehead, which are

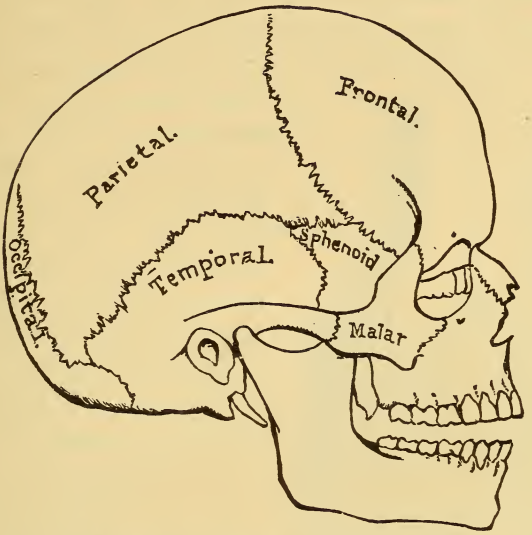


FIG. 12.—The Human Skull, Looked at from the Side.

FIG. 13.—The Bones of the Skull Separated. 1, Frontal; 2, Parietal; 3, Occipital; 4, Temporal; 5, Nasal; 6, Malar; 7, Upper Jaw; 8, Lachrymal; 9, Lower Jaw.

known as the *orbits* and receive the eyes. Below and between these is the triangular opening of the nose, bounded above by two small bones (5, Fig. 13) called the *nasal* bones. To the outer side and below the orbits are the bones which form the prominence of the cheeks, and are called the *malar* bones (6, Fig. 13). At the lowest part of the face are the two *jaws*, the *upper* (7, Fig. 13) and the *lower* (9, Fig. 13). The *upper jaw* is firmly joined to the rest of the skull; the *lower jaw* resembles a horseshoe in shape, and is separate from the rest of the skull, though connected, of course, during life, to the sides of the face by strong bands and muscles. Each jaw has a circular row of teeth, about which more will be said in the chapter on Digestion. Between these two rows of teeth is the mouth.

FIG. 14.—The Spinal Column, as Seen from Front.

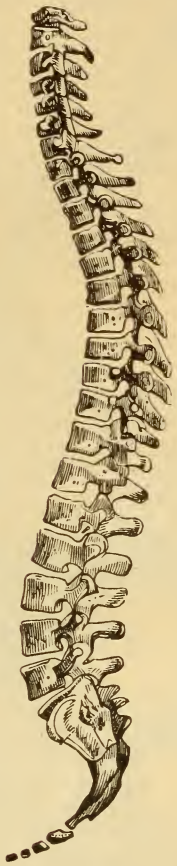


FIG. 15.—The Spinal Column, as Seen from the Side.

The skull rests upon the upper end of the spinal column and is very movable, so that it can be bent forward or backward, or from side to side, and can be turned in any direction.

Bones of the Trunk.—The bones of the trunk are: the bones forming the spinal column, the hip-bone, the collar-bone, the shoulder-blade, the breast-bone, and the ribs.

The Spinal Column.—This is the row of bones

which extends from the skull above to the lower limbs below. There are thirty-three of these bones piled one upon another; but in the grown person there are fewer, because the lowest nine bones unite so as to form but two; of these five form the upper one, called the *sacrum*, and four unite to form the tip of the spinal column, called the *coccyx*. There are thus really but twenty-six separate bones in the spinal column. Each of these twenty-six bones is called a *vertebra*, and all of them taken together are known as the *vertebræ*. The spinal column is often called the *backbone*, on account of its extending along the middle of the back. The vertebræ are connected by circular plates of gristle, or cartilage, and by fibres. This cartilage and the fibres are elastic, and thus it is that our backbone is very movable—we can bend it in any direction or twist it because the cartilage gives. This also explains why it is that at night we are a trifle shorter than in the morning, for the weight of the body has caused these plates of cartilage between the vertebræ to be compressed slightly, while after a rest during the night, they regain their usual thickness. There is an opening in each of the vertebræ, and when they are all in position, these openings connect and form a canal, the *spinal canal*, which runs all through the backbone. This canal holds the delicate *spinal cord*, from which nerves emerge through small openings on each side of the spinal column. At the upper end of the spinal canal it communicates with the cavity of the skull by means of

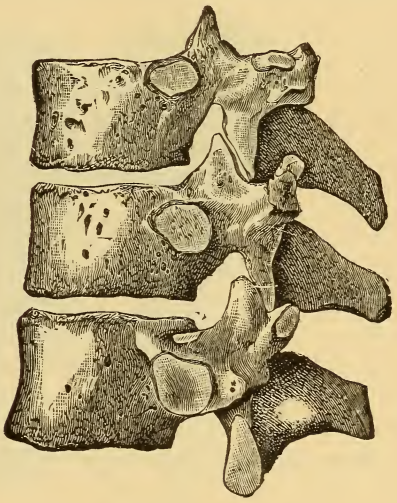


FIG. 16.—Three Vertebræ from the Lower Part of the Spinal Column, Separated.

a large oval opening, through which the spinal cord and the brain are directly continuous. If you run your finger along the middle of the back, you can feel projecting points; these are the tips of the vertebræ.

The Hip-bones (*H*, Fig. 21 and Fig. 17) are the two large and strong bones which are placed on each side of the lower end of the spinal column, forming with it a sort of basin which is called the *pelvis*. On the outer side of each hip-bone,

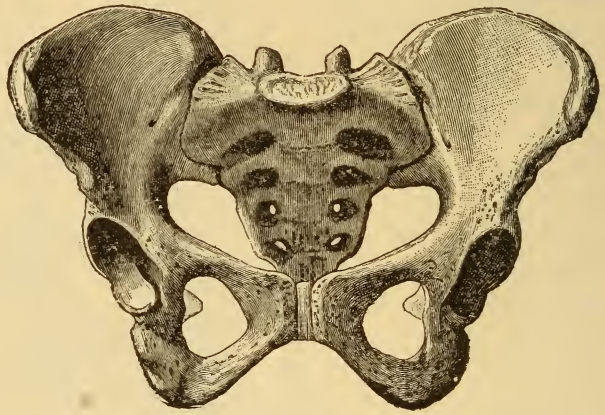


FIG. 17.—The Pelvis, formed by the Lower End of the Spinal Column and the Hip-bones.

at about its middle, will be noticed a deep, round depression; in this fits the upper end of the thigh-bone.

The Collar-bone, or **Clavicle** (Figs. 4 and 19, *C*), is the curved bone which we feel at the upper part of the chest in front, being connected with the breast-bone at its inner end.

The Shoulder-blade, or **Scapula** (Fig. 19, *B*), is the large triangular bone which we feel at the upper part of the chest behind. It lies behind the upper ribs. At its outer angle is a round depression into which the upper, ball-like end of the bone of the arm fits.

The Breast-bone, also called the *sternum* (Fig. 19, *S*),

is a flat bone, broad above and gradually tapering toward its lower end. It forms a strong guard to the front of the chest. Along its edges the ribs are attached on each side.

The Ribs.—There are twenty-four ribs, twelve on each side. They are long, slender, curved bones, which form the outer boundary of the chest. They are very elastic. All the ribs are joined behind to the vertebræ of the back. The first seven are attached to the breast-bone in front, and are called

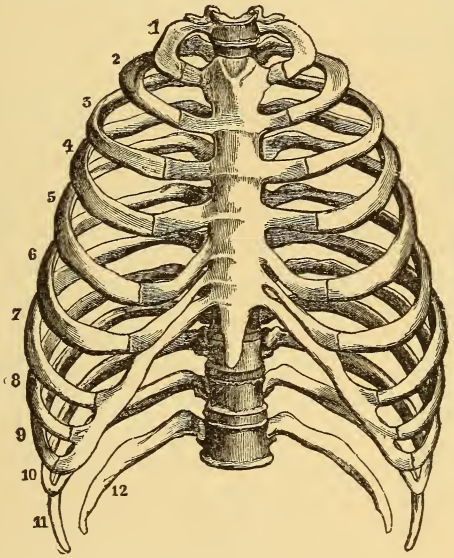


FIG. 18.—The Chest, or Thorax.

true ribs; the last five are not attached to the breast-bone in front, and are called *false* ribs; the upper three of these, namely, the eighth, ninth, and tenth, are connected with cartilage in front, but the last two are entirely free in front, and are called *floating* ribs.

The Chest, or **Thorax** (Fig. 18).—It has already been explained that this is the large cavity just below the neck which serves to hold the heart and lungs. These organs are of great importance, and are nicely boxed in by the bones we have just

studied; namely, the breast-bone in front, the ribs on each side, the collar-bone above, and the backbone behind. There are, of course, spaces between these different bones, but in the living body they are filled with muscles. A flat sheet of muscle-tissue also bounds the chest below and separates it from another cavity, situated just below it, the *abdomen.* This muscular partition is called the *diaphragm.*

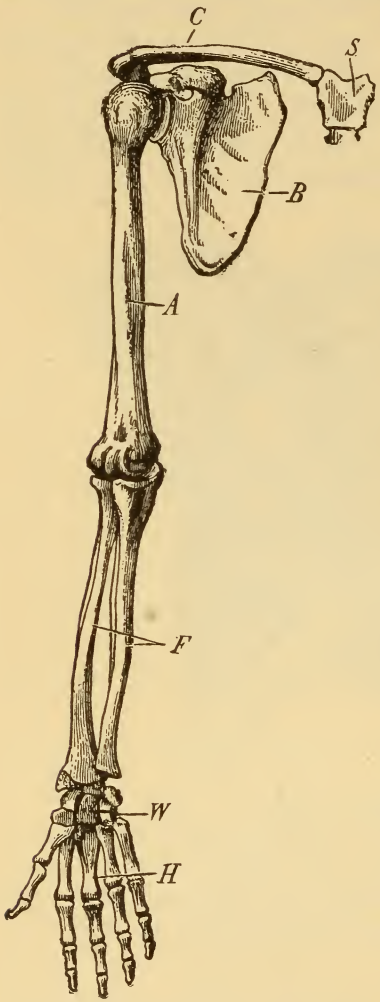


FIG. 19.—The Bones of the Upper Limb. *S*, Breast-bone (Sternum); *C*, Collar-bone (Clavicle); *B*, Shoulder-blade (Scapula); *A*, Bone of Arm (Humerus); *F*, Bones of Fore-arm (Radius, Ulna); *W*, Bones of Wrist; *H*, Bones of Hand.

Bones of the Upper Limb.—These are: the bone of the arm (humerus); the two bones of the forearm (radius and ulna); and the small bones forming the hand.

The Bone of the Arm is a single bone, known as the *humerus.* It is a strong bone and extends from the shoulder to the elbow. Its upper end has an enlargement, shaped like a ball, which fits into the cup-shaped depression, seen at the outer angle of the shoulder-blade.

The Bones of the Forearm.—There are two bones in the forearm, an outer, the *radius,* and an inner, the *ulna.* They are placed side by side, the space between them being filled with a membrane

and muscles. They extend from the elbow to the wrist. In twisting the forearm the radius revolves around the ulna, which is the less movable of the two.

The Bones of the Wrist and Hand.—There are twenty-seven bones in each hand. The hand may be divided into three parts: The *wrist*, or *carpus;* the *palm*, or *metacarpus;* and the *fingers*, or *phalanges*. The *wrist* is the most solid part and is made up of eight small bones, more or less rounded or cubical in shape, closely held together by tough bands. This arrangement serves to make the wrist very strong and still very light. The bones forming the *palm* of the hand are five in number. Each *finger* has three bones, the end of one being joined to that of the other, except the thumb, which is shorter and has but two such *phalanges;* this arrangement of the bones of the fingers allows them to move very dexterously.

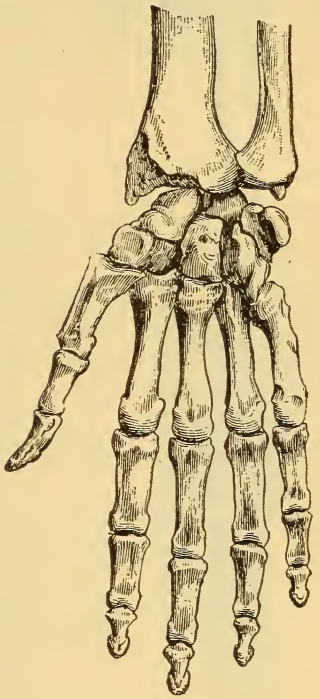


FIG. 20.—The Bones of the Wrist and Hand. Above is also seen the lower ends of the radius and ulna, taking part in forming the wrist-joint.

Bones of the Lower Limb.—These comprise the *thigh-bone* (*femur*), the bones of the leg (*tibia* and *fibula*), the *knee-pan* (*patella*), and the bones of the *foot*.

The Thigh-bone, or **Femur,** is the largest and strongest bone in the body, and is surrounded by more muscle than any other bone. Where it is attached to the hip-bone it has a large spherical part called its *head*, and this forms an angle with the rest of the bone by a part called the *neck*. Below, the thigh-bone joins with the bones of the leg and with the knee-pan.

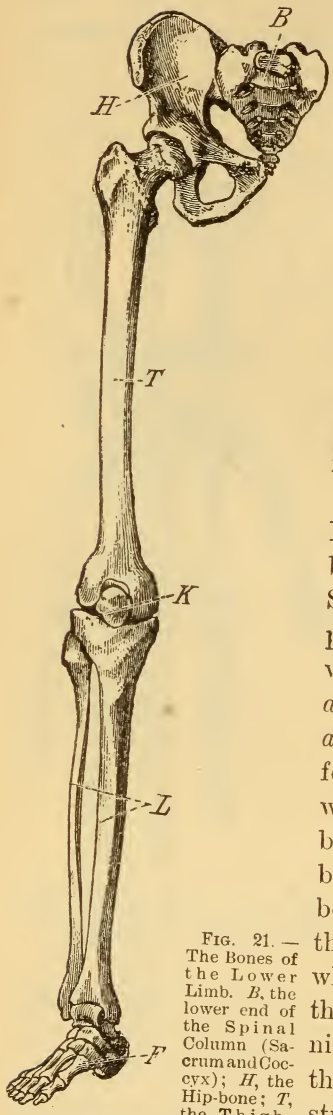


FIG. 21. — The Bones of the Lower Limb. *B*, the lower end of the Spinal Column (Sacrum and Coccyx); *H*, the Hip-bone; *T*, the Thigh-bone (Femur); *K*, the Knee-pan (Patella); *L*, the Bones of the Leg (Tibia and Fibula); *F*, the Bones of the Foot.

The Knee-pan, or Patella, is the small, round, flattened bone which can be felt at the knee. It serves as a protection to the joint, and often saves it from injury in falls and blows.

The Bones of the Leg.— There are two bones in each leg. The inner bone is the shorter and stronger of the two, and is called the *tibia*. The outer bone is longer and more slender; it is called the *fibula*. These two bones, placed side by side, extend from the knee to the ankle.

The Bones of the Foot.— Each foot is formed by twenty-six bones, one less than in the hand. Seven of these form the solid back part of the foot, called the *tarsus*, which includes the *heel;* five form the *arch* or *instep*, also known as the *metatarsus;* and the remaining fourteen form the *toes* or *phalanges*. Thus, it will be seen, that there are as many bones in the toes as in the fingers; but the toes are much less movable, being simply intended for support of the body and for walking; however, when they are trained to do other things, they may become almost as nimble as the fingers are. The *heel* is the most solid part of the foot and the strongest. The *sole* of the foot, between the heel and the toes, forms an arch at the inner border of the foot;

which arch breaks the force of jumps from heights. If we are compelled to jump from a height, there is the least disagreeable effect and danger to the body if we alight on our toes, or just behind the toes, upon the soft cushion known as the *ball* of the foot, for when we reach the ground upon the heel, the shock is transmitted through the entire body, and gives rise to a very disagreeable sensation, and possibly even to injury.

SYNOPSIS.

Position—1. Internal in higher animals. 2. External in some of lower animals.

Uses of the bones : 1. Support to rest of body. 2. Protection to delicate organs. 3. Strength and hardness. 4. Motion, by serving as points of attachment for muscles.

Number of Bones : Two hundred.

Forms of Bones : 1. Long. 2. Short. 3. Flat. 4. Irregular.

Structure of Bone : 1. Outer dense layer. 2. Interior porous and light. 3. Central canal filled with marrow in long bones. 4. Blood-vessels pass through it, giving pink color during life. 5. Covered by membrane (periosteum).

Composition of Bone :

1. Animal matter—About one-third in amount.
   Larger proportion in early life.
   Gives toughness and elasticity.
2. Mineral matter—About two-thirds in amount.
   Larger proportion in advanced life.
   Gives rigidity.

Care of the Skeleton :

1. Avoid faulty positions, to prevent stooping and round shoulders.
2. Avoid tight clothing, to prevent deformed chests.

3. Avoid faulty shoes, to prevent deformities of the feet, corns, bunions, and accidents.

4. Extensive indulgence in alcoholic drinks and other narcotics may prevent bones from growing to natural size.

5. When general health suffers, growth of bones is interfered with.

Fracture of a Bone :

1. "Setting" the bone.

2. To prevent further injury, the broken part should be kept quiet until the doctor arrives.

3. Method of healing by material binding the two ends together.

Parts of the skeleton :—

1. The Head :
   - *a.* Cranium—1. Frontal.
     2. Parietal.
     3. Occipital.
     4. Temporal, etc.
   - *b.* Face—1. Nasal
     2. Malar.
     3. Upper jaw.
     4. Lower jaw, etc.

2. The Trunk :
   - *a.* Spinal column (composed of 33 vertebræ).
   - *b.* Chest (formed by vertebræ, sternum, clavicle, and ribs).
   - *c.* Ribs—1. True.
     2. False (including two floating ribs).
   - *d.* Collar-bone (Clavicle).
   - *e.* Shoulder-blade (Scapula).
   - *f.* Breast-bone (Sternum).
   - *g.* Pelvis (formed by lower end of spinal column and hip-bones.

3. The Upper Limb :
   - *a.* Bone of arm (humerus).
   - *b.* Bones of forearm—1. Radius.
     2. Ulna.
   - *c.* Bones of hand—1. Wrist (Carpus).
     2. Palm (Metacarpus).
     3. Fingers (Phalanges).

4. The Lower Limb :
   a. Bone of thigh (Femur).
   b. Knee-pan (Patella).
   c. Bones of the leg—1. Tibia.
   2. Fibula.
   d. Bones of foot—1. Heel (Tarsus).
   2. Arch (Metatarsus).
   3. Toes (Phalanges).

QUESTIONS.

1. What is meant by the word "skeleton?" 2. How does the skeleton of a crab and lobster differ from that of man? 3. What are the uses of bone? 4. How many bones are there in the human body? 5. Mention the different forms of bones. 6. Which part of the bone is the hardest? 7. How does the inner part of the bone differ from the outer layer? 8. What is marrow? 9. Of what substances is bone composed? 10. How can you show that bone is made up of these two substances? 11. How do the bones of a baby differ from those of a middle-aged man? 12. How do the bones of an old man differ from those of a younger man? 13. Tell something about the care of the skeleton. 14. Why is it necessary to sit and to stand erect? 15. What happens when we wear our clothing too tight? 16. What is a fracture? 17. What effect may alcohol and tobacco have upon our skeleton? 18. What effect does smoking have upon the size of boys? 19. Will the growth of our bones take place properly if our health is poor? 20. Into what four different parts can we divide the skeleton? 21. What are the bones of the head taken together called? 22. What is the cranium and how many bones join to form it? 23. How are the bones of the cranium united? 24. Where is the frontal bone? 25. What does the prominence of the forehead show? 26. Where are the orbits? 27. What is peculiar about the lower jaw? 28. Name the bones of the trunk. 29. What are the vertebræ? 30. How many are there? 31. How are they connected together? 32. What opening is there in the spinal column? 33. What can you say about the hip-bones? 34. Where is the collar-bone? 35. Where is the shoulder-blade? 36. What is another name for the breast-bone? 37. What is its

use? 38. How many ribs are there? 39. What does a rib look like? 40. Which are the true ribs? 41. Which are the false ribs? 42. What is a floating rib, and which ribs are called floating? 43. What is the chest, and what does it contain? 44. What is another name for it? 45. What bones form the boundaries of the chest? 46. What is the diaphragm, and what cavities does it separate? 47. What bones are there in the upper limb? 48. How many bones are there in the arm? 49. How many in the forearm? 50. How many bones are there in the hand? 51. How is the wrist formed? 52. How many bones are there in each finger? 53. How many bones are there in each lower limb? 54. Which is the largest bone in the body? 55. Describe the thigh-bone. 56. How many bones are there in the leg? 57. Describe the knee-pan and its use. 58. How many bones in the foot? 59. Which are the more movable, the toes or the fingers? 60. Which is the strongest part of the foot? 61. In jumping from a height, upon what part of the foot should we alight, and why? 62. What are the dangers of high heels? 63. What are the effects of too small or badly-formed shoes?

CHAPTER III.

THE JOINTS.

Wherever two or more bones meet is a *joint.* Joints are necessary in order that one part of the body may move independently of the other. If this arrangement did not exist, we should have to move the entire body whenever we wanted to move any part of it. If you observe how a man walks when his knee-joint, for instance, is stiff and cannot be used, you will appreciate how useful joints are. The more joints there are in any part of the body the more movable is that part; notice, for instance, how movable the fingers are and how many joints there are in the hand.

According to the amount of motion which they permit, joints are divided into three classes:

(1.) *Immovable* joints, in which there is no visible motion.

(2.) *Slightly-movable* joints, in which there is slight motion only.

(3.) *Movable* joints, in which there is free motion.

Immovable Joints.—The best example of this form of joint is seen in the skull. The flat bones of the skull are fastened together by means of the small projections from their edges. Such joints are called *sutures.* They are very well adapted to what is required here, because being closely joined they make a strong box of the bones of the skull, and yet they are capable of a very little motion, enough to break the force of blows upon the head. In this way they serve as additional protection to the brain.

Fig. 22 shows the sutures which we find on the upper surface of the skull. In front, joining the frontal bone with

the two parietal bones, there is a suture which extends across the skull from one side to the other. It is called the *coronal* suture, from the Latin word *corona,* which means *crown,* because the front part of the crown of a king is supposed to rest upon this line. Behind, where the occipital bone meets the two parietal bones is another suture, called the *lambdoid,*

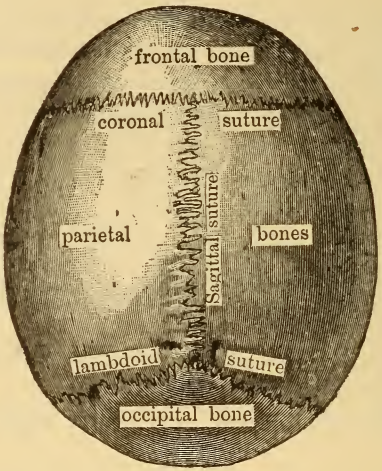


FIG. 22.—View of the Skull from Above, Showing the Sutures.

on account of its resemblance to the Greek letter *lambda* (Λ). Between these two sutures, the coronal and the lambdoid, is another which connects the two parietal bones. It is called the *sagittal* suture, from the Latin word *sagitta* (an arrow), because it was thought to join the coronal suture as an arrow meets the string of a bow.

Slightly movable Joints.—In these joints a fair amount of motion is allowed, but much less than in the next class—the movable joints. We find examples of slightly movable joints between the different vertebræ forming the spinal column.

Movable Joints.—These are the most numerous and

the most interesting. In all movable joints the same general arrangement exists: the ends of the bones forming the joint are covered with gristle or cartilage, a dense, semi-transparent substance much softer than bone, acting as a cushion to the ends of the bones, so that they are not bruised or injured when the joint is moved, or when the ends are brought together forcibly, as in jumping.

If two surfaces rubbing against each other were dry they would soon be rubbed off; hence it is necessary to keep a joint moist all the time. In machinery this is accomplished by oil. In the living body the same thing is done by a yellowish fluid looking like the white of an egg, which constantly covers the ends of these bones. This fluid is given off from the inner surface of a sac which lines all movable joints. This sac or membrane is called the *synovial* membrane, and the fluid which it gives off is called *synovial* fluid. The ends of the bones forming joints are held in place and connected by strong bands of tough tissue, which pass from one bone to the other, and are called *ligaments*. This is shown in Fig. 23, which represents a joint cut in two; the bands on the outside, one on each side, passing from the upper to the lower bone, are the ligaments. Sometimes these are so extensive as to surround the entire joint, and thus be a cover to it. This entire covering is called the *capsular ligament*, because it is like a capsule; this is seen in Fig. 24.

Varieties of Movable Joints.—There are four varieties of movable joints:

(1.) *Gliding*-joint—in which one bone slides upon the other, as between some of the small bones forming the wrist.

(2.) *Hinge*-joint—in which one bone swings forward and backward from the end of the other, just as a door opens and closes upon its hinges. A good example of this form of joint is seen in the connection of the arm with the forearm at the elbow.

(3.) *Pivot*-joint—in which one bone turns upon the other by an arrangement resembling a pivot. This is seen in the connection between the skull and the upper end of the spinal column.

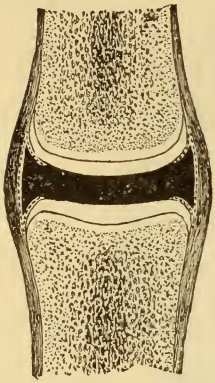


FIG. 23.—One of the Movable Joints Sawed through Lengthwise, with the Different Parts in their Proper Position, thus Showing the General Arrangement in Joints.

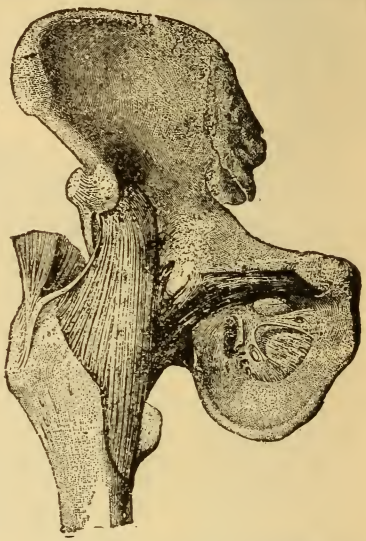


FIG. 24.—The Hip-joint, Showing the Capsular Ligament Surrounding the Junction between the Hip-bone Above and the Thigh-bone Below.

(4.) *Ball-and-socket*-joint. This is a form of movable joint in which the greatest amount of motion is allowed. One bone ends in an enlargement like a ball which fits into a socket of the other bone; hence the term *ball-and-socket.* Examples of this form of joint are seen in the shoulder and hip.

Accidents to Joints.—When one of the bones which forms the joint is not in its correct position and no longer fits on the end of the other, we say that it is *out of joint* or *dislocated.* This accident is very painful. The bones must be put *in joint* again by the surgeon. Often the capsular ligament is torn. The accident is usually the result of falls. Many such falls take place in getting off street-cars, especially if the car

has not come to a full stop, and the person does not remember to get off facing the horses.

SYNOPSIS.

Definition—The place of meeting of two or more bones.
Uses—To allow greater freedom of motion.
Varieties—According to amount of motion permitted·

1. Immovable—no visible motion—sutures :
   - *a.* Coronal.
   - *b.* Lambdoid.
   - *c.* Sagittal, etc.
2. Slightly-movable—slight motion.
3. Movable—free motion.
   - *a.* Ends covered with cartilage.
   - *b.* Upon this is synovial membrane.
   - *c.* Kept lubricated by synovial fluid.
   - *d.* Bones connected and held in place by ligaments.
   - *e.* Four different forms :
     1. Gliding-joint.
     2. Hinge-joint.
     3. Pivot-joint.
     4. Ball-and-socket-joint.

Accidents—Dislocations—*out of joint.*

QUESTIONS.

1. What is a joint in anatomy? 2. What advantage is there in having joints in the body? 3. What classes of joints are there? 4. Give an example of an immovable joint. 5. What is a suture? 6. Name the most important sutures of the skull, and describe each one. 7. Give an example of a slightly movable joint. 8. Describe the general arrangement in movable joints. 9. How are such joints kept moist? 10. What is cartilage? 11. What are ligaments? 12. How are the ends of bones forming joints held in place? 13. What is a capsular ligament? 14. What forms of movable joints are there? 15. What is a gliding joint? 16. Give an example. 17. What is a hinge joint? 18. Give an example. 19. What is a pivot joint? 20. Give an example. 21. What is a ball-and-socket joint? 22. Give an example. 23. What is a dislocation?

FIG. 25.—The Muscles of the Human Body (the Skin having been Removed).

CHAPTER IV.

THE MUSCLES AND MOTION.

Thus far we have been studying the framework of the body and we found this to consist of about two hundred bones, which together we spoke of as the *skeleton ;* we found also that these bones were held together by tough tissues, called *cartilage* and *ligaments ;* we saw that there were a great many joints, so that one bone could move upon another. All these formed the *framework.* Over this is a soft, but firm and elastic, covering which we call the flesh. It is composed chiefly of bands of tissues called muscles. These are overlaid with fat, which is covered with skin, and all are threaded with innumerable nerves and blood-vessels. We shall first study the muscles.

Function, or Work of the Muscles.—Muscles give us the *power of moving the different parts of the skeleton.* Our skeleton would be of very little value to us if we could not move the different bones ; just as the sails of a ship would be of little use unless there were ropes and pulleys to hold and move them.

Description of Muscle Tissue.—The chief part of beef and mutton which we eat is muscle tissue. It is red, owing to the blood which circulates through every part of it. A muscle is composed of innumerable fibres, which lie side by side like a bundle of threads. These bundles are bound together with sheaths of thin transparent connective tissue. A great many taken together form a whole muscle, as, for instance, the biceps. This connective tissue may be seen in chipped beef as a fine network of white veins, for salting

causes it to turn hard and white. Each individual fibre is made up of smaller and still smaller fibres, which can only be seen under a microscope. Some of these finest fibres which belong to the voluntary muscles are striped, while others are like long narrow spindles. (Fig. 26.)

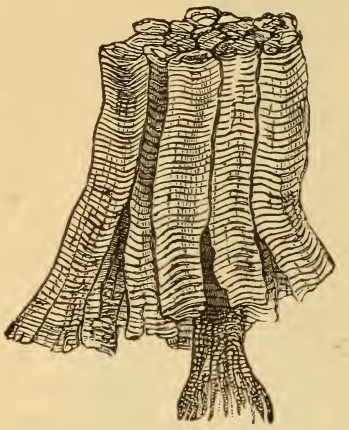


FIG. 26.—A Piece of a Muscle Separated into its Fibres and Showing the Striped Appearance of the Fibres. (Magnified several hundred times.)

Tendons.—Muscles are not themselves directly attached to the bone, but are attached to strong tough cords, known as tendons, which connect them with it. The tendons are white and shining and hence can easily be distinguished from the muscles. They are of great strength, and it is very rare for any of them to break. The central, thick, fleshy part of a muscle is called its *belly*. In Fig. 27 the belly of the muscle is marked *B*, the ends or tendons *T*. If you feel the fleshy mass on the front of the forearm, you are feeling *muscle*. But if you put your finger at the wrist, and open and close your hand, you will feel hard cords move; these are the tendons of the muscles of your forearm and serve to attach the muscles to the bones of your fingers.

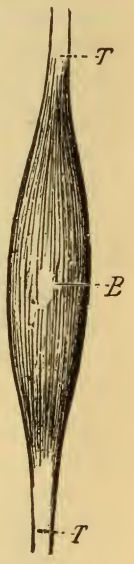


FIG. 27.—A Long, Fleshy Muscle. *B*, Belly; *T*, *T*, Tendons.

Fat.—The different muscles always have a little fat mixed with them which cannot be separated. But, besides this smaller quantity, there is more or less fat in layers between the different muscles; there is also fat covering the muscles and between the muscles and the skin. Meat free from fat is said to be *lean*.

Uses of Fat.—A certain amount of fat is necessary, and it is useful in the following ways:

(1.) It *keeps the body warm.* Fat does not allow the heat of the body to pass out readily, and so it protects us from the cold.

(2.) It *protects the body from pressure.* Just beneath the skin is a layer of fat, thick at some places, and thin at others. Where the body is exposed to much pressure the layer of fat is thick, preventing us from feeling the weight of the body. In the palms of the hands and the soles of the feet, for example, there is much fat; otherwise our hands and feet would ache every time we used them considerably.

(3.) Fat is a *food.* When persons are deprived of food they may live for a number of days, for the fat of their bodies is changed into nourishment which the blood takes up and furnishes to different parts of the body. As examples of this we have cases in which persons who were shipwrecked, or who stowed themselves away in the hold of a ship so as to steal a passage, have survived many days. The tissue which suffers most is the fat; this disappears, and on this account such persons rapidly become very thin.

(4.) Another use of fat is to give a fine *appearance* to the body. It fills up the uneven spaces that would be left between muscles and bones. If it were not for this the entire body would be uneven and lumpy. In the baby, where the muscles are small and undeveloped and there is considerable fat, the outline of the body is nice and round. As the baby gets older the muscles become larger, and the amount of fat smaller, and the body is no longer so plump and rounded. Where the muscles are well exercised much of the fat is absorbed and the muscles stand out prominently. But still there is always some fat present.

Kinds of Muscle-tissue.—Muscle-tissue is of two kinds. One variety, to which most muscles belong, is under the *control of the will;* hence such muscles are known as *volun-*

tary muscles, *directed by the will.* Such muscles remain in a state of rest until we desire to use them. All the muscles on the outside of the body are of this class. The muscles of our arm, for instance, remain at rest during sleep, and at other times when we do not care to make use of them. Voluntary muscle-tissue appears striped when looked at under the microscope.

The other class of muscles we call *involuntary*, that is, *not directed by the will.* These muscles are situated inside the body; as examples may be mentioned the heart, the layer of muscle which is found in the walls of the stomach and intestines, and the muscular fibres in the walls of the arteries and by which these blood-vessels are made to contract. We cannot control the action of these muscles; they act without our being conscious of it, and it is well that it is so. Take the heart, for instance; day and night it is at work pumping the blood into the blood-vessels, to be carried all over the body. If we had to watch over this organ, to see that it kept on beating, we should always have to stay awake; and if we were careless and fell asleep, and the heart stopped because we were not directing it to keep on beating, life would soon cease. As another example, let us look at the working of the stomach. After food enters this organ the muscular fibres in its wall begin to contract and move the food about, so as to break it up into finer particles; this is done without our knowing anything about it, and without our being able to control it. Involuntary muscle-tissue presents *no* striped appearance under the microscope.

Mixed Muscles.—Some muscles belong partly to one class and partly to the other; for instance, the muscles between the ribs, which move the latter in breathing. These act all the time; yet we may not be aware of their action, which continues whether we are asleep or awake. Still we can stop breathing for a very short time, or we can breathe more rapidly than is natural for a very short time—but only for a short

time. These muscles are *partly voluntary and partly involuntary.*

How Muscles Act.—The peculiar characteristic of muscle-tissue is its power to contract or to draw up, and then relax. An electric shock will cause it to contract, and the impulse that travels along the nerve-fibres from the brain has

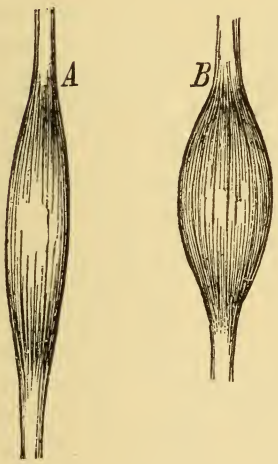


FIG. 28.—*A*, a Muscle at Rest; *B*, the same Muscle Contracted. It has become shorter, broader, and thicker.

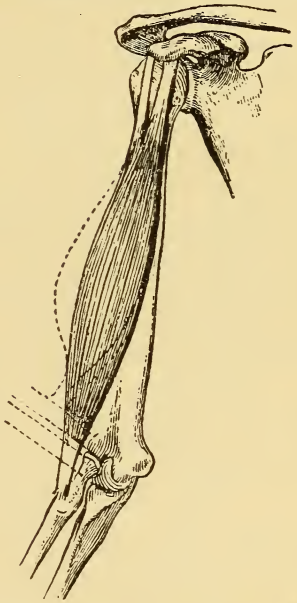


FIG 29.—The Action of the Biceps Muscle of the Front of the Arm. (The dotted figure shows the effect of the contraction upon the position of the forearm.)

the same effect. When the muscle contracts it becomes shorter and its ends are nearer together, consequently the bones to which it is attached by its tendons are pulled toward each other. When a muscle is contracted and relaxed by exercise in proper amount it grows large and firm and very strong —it has become shorter, thicker, and harder. Since the muscle cannot break loose from its attachment to bones, it must bring these bones nearer together when it shortens. Fig. 28 shows a long, fleshy muscle at rest (*A*), and the same muscle

after contraction (having become shorter, thicker, and broader), to the right (*B*). In Fig. 29 the manner in which the contraction of a muscle causes motion is shown. The picture illustrates the biceps muscle on the front of the arm. It is attached above to the shoulder-blade (which is the fixed point), and below to one of the bones of the forearm (the movable attachment). The dotted figure shows the muscle after it has contracted—in order to shorten it must bend the forearm, so as to bring its two points of attachment nearer together.

Though muscles have the power to contract, they cannot do this unless we direct it; and the order to act comes from the brain. If the brain wishes a certain muscle to act, it sends it a message, and then the muscle responds. This message goes from the brain to the soft, whitish matter in the canal running through the centre of the spinal column, known as the *spinal cord;* from the spinal cord the message is sent directly to the muscle by certain white threads, which we call *nerves.*

This whole arrangement is very much like a *telegraph office:* the brain corresponds to the office to which messages come and from which messages are sent out, and the nerves we may liken to the telegraph wires or messengers which carry the despatches. The following example will illustrate this: Suppose you see an orange on the table before you. The eye sends a message to the brain, by means of the nerve of the eye, that the orange is there. You are heated and thirsty, and would like to eat the orange. The brain then sends out a message to the muscles that move your fingers and to those that move your arm that they are to seize the orange, and they obey. The message from the brain was carried down through the nerve-tissue in the backbone, the spinal cord, then through the nerves of the arm to their smallest branches, which pass to the muscles.

Although the muscles contract, and thereby cause the movement of the arm, forearm, and fingers, they are only the *servants of the brain and nerves;* without an order from

the brain through the nerves they could not move. This is proven by the fact that when, from an injury, the nerves of the forearm are cut across, the muscles of the forearm and hand become lame, and we say they are *paralyzed*. If we examine them we may find no change, but they can no longer receive orders to act from the brain, and on this account are motionless.

Ordinary Muscular Movements are very Complex.—It is so easy for us to make use of our muscles that we are apt to believe every act which they perform very simple, but this is not the case. Even the very simplest acts involve the use of a great many different muscles. When we walk, for instance, we do not even give it a thought, yet very many different muscles are acting, each one with great skill and nicety. It is on this account that man cannot construct machinery that will perform many of the things done by his hands. No machine could be constructed, for instance, that could write, or draw, or paint to imitate the work done by hand. Even when we stand there are a number of muscles at work balancing the body. After standing a long time, owing to the fact that these muscles become worn out, we feel tired.

Groups of Muscles.—Usually we find that muscles occur in sets, or groups, and that one set accomplishes just the opposite action from the other. Thus the muscles on the front of the forearm serve to close the fingers and hand, while those on the back of the forearm serve to open them. The large muscle on the back of the arm, called the *triceps*, straightens out the forearm, while the thick muscle in front of the arm, called the *biceps* (Fig. 30), bends the forearm upon the arm.

All the different *expressions of the face* are produced by the action of the small muscles of the face. When they draw up the corners of the mouth they give rise to a look of pleasure and smiling; if they draw down the corners of the mouth they produce an expression of sadness and displeasure. They may wrinkle the forehead horizontally and make the face look in

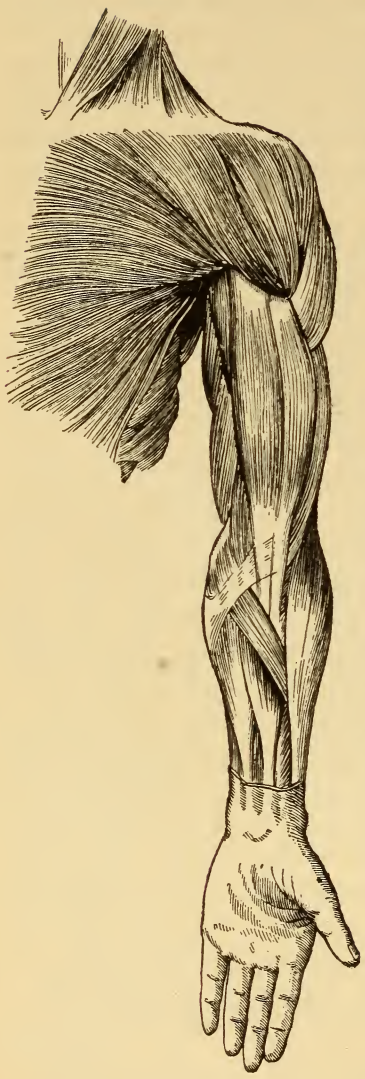


FIG. 30.—The Muscles of the Front of the Chest, Arm, and Forearm. The fan-like muscle above and to the left is the "pectoralis;" in the centre of the arm is seen the "biceps."

doubt, or wrinkle it vertically, producing a frown. There are many other varieties of expression. The expression of the face soon becomes that which the person himself habitually uses. If you look sullen and angry all the time the face will soon have this expression, because the muscles become so accustomed to acting in this way that they cannot do otherwise. In the same way you may have a constant silly expression, if you act the part of a fool every time you are with your companions. Some children are in the habit of twisting their eyes so that they look cross-eyed. This they often do to make their friends laugh. They should remember that from constantly doing this the eyes may be injured.

Number of Muscles.—There are about *three hundred* muscles on each side of the body, making about six hundred in all.

Nearly all the muscles occur in pairs, that is, are the same on one side as on the other. A few muscles which exist in the middle line of the body are single.

Shape of Muscles.—Muscles vary greatly in shape.

The most frequent form is that of a long, fleshy bundle with a tendon at either end for fastening it to bone. Sometimes they are flattened and placed in layers, as is the case in the muscles of the wall of the abdomen. Some muscles consist of flattened bundles which come together toward a single point like a fan; such is the muscle of the temple—the *temporal* muscle. Other muscles are square-shaped, and still others form a circular ring; so that there is great variety in the shapes of muscles.

Size of Muscles.—Here, too, there are the greatest differences. Some of the muscles in the interior of the ear are only a fraction of an inch in length. Some of those of the eye are about an inch in length, while the longest muscle is one which extends from the hip to below the knee, and is over two feet in length. Between these two extremes there are many different sizes.

A Few Important Muscles.—It is not necessary for you to remember the names of many of the muscles, but there are a few which are worth remembering, because they are important, and because we often see them mentioned in books and newspapers. They are the following:

FIG. 31.—The Biceps and Triceps Muscles.

The Biceps is the large fleshy muscle on the front of the arm, which bends the forearm upon the arm (Figs. 30 and 31). It can be felt upon making this motion.

The Triceps is the muscle of considerable size which can be felt upon the back of the arm. It serves to straighten out the forearm after the biceps has bent it.

The Chest-muscle, or *Pectoralis* (Fig. 30), forms the prominence at the upper part of the chest on each side. It is trian-

gular in shape, like a fan. It draws the arm inward across the chest.

The Diaphragm is the sheet of muscle which separates the cavity of the chest from that of the abdomen. It is of great importance, and is one of the principal muscles concerned in breathing. It is an involuntary muscle.

The Tendon of Achilles.—This is the strong, thick cord which you can feel at the back and lower part of the leg, just above the heel. It is the end of a very large and powerful muscle which raises the heel when we walk. It has received its name from the following story: Achilles was a Grecian hero. There was supposed to be a river, the Styx, of which it was said that whoever bathed in its waters could not be wounded. The mother of Achilles wishing to preserve her son from all future danger, dipped him into this river Styx, holding him by the heel. All parts of his body were wet except the heel by which he was held, and at this place he is said to have received his death-wound.

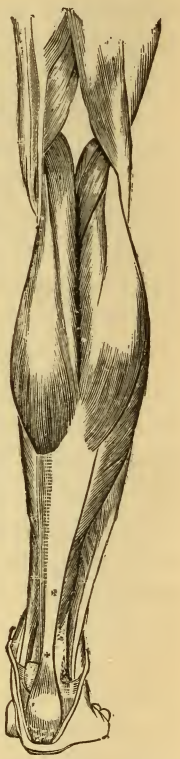


FIG. 32.—The Muscles of the Back of the Leg, showing Below (* *) the Tendon of Achilles.

Effect of Alcohol on the Muscles.—You have learned that the muscles cannot act without receiving a message from the brain through the nerves. This message may be prevented from reaching the muscle by pressure, which for a few moments stops the nerve-current from acting, as when by sitting on your foot or lying on your hand you find that the hand or foot is "asleep." It has no sensation except a prickly feeling, and it will not obey orders.

Every time a person takes even a small amount of any alcoholic drink, the muscles are affected in somewhat the

same way, but without the numb feeling. If a man tries to aim at a target with a pistol, his brain sends the message to hold his hand steady and true. But, try as he will, his hand shakes, for the nerves are not able to control the muscles. A surgeon needs a very steady hand to perform delicate operations; if his knife slips or goes a little too deep, because his muscles have lost their control through drink, he may lose the life he is trying to save. Sir Andrew Clark, one of Queen Victoria's physicians, says: "Every man who comes to the front of a profession in London is marked by this one characteristic, that the more busy he gets, the less in the shape of alcohol he takes, and his excuse is, 'I am sorry, but I cannot take it and do my work.'"

Men who use their fingers for any fine work, such as writing, engraving, making watches or fine machinery, as well as artists and musicians, find their hands less steady after drinking liquor, and though they may be experts, and have finely trained muscles, yet if they get into the habit of taking alcoholic drinks, their muscles lose their tone, and cannot do good work.

Dr. B. W. Richardson says: "This is because the nervous control over the muscles is gone. The muscles themselves also fail in power; they respond more feebly than is natural to the nervous stimulus; they, too, are coming under the depressing influence of the paralyzing agent. Their structure is temporarily deranged and their contractile powers reduced."

Every automatic muscular movement, such as putting the foot down to walk, or extending the hand to grasp something, requires a message from the brain, even though we may be unconscious of it. A man under the influence of liquor lacks what is called perfect co-ordination between the nerves and the muscles. He thinks he is going to put his foot on a step, but misses it and falls. He has lost control of his muscles; his hands let fall what he thinks he is holding; his head

droops to one side, his mouth is open. The muscles of his tongue are not under control, and he stammers and mutters unintelligibly.

Scientific men state that less muscular labor can be performed under the influence of alcohol than without it. They have made experiments upon armies both in hot and cold countries, and have found that the men could endure long marches and could figh t better whenthey had been allowed no strong drink, even in small quantities, with their rations. Although the spirits would seem to revive and stimulate them for a little while, they would be exhausted sooner when they had taken it. All men in training for great muscular contests give up alcoholic drinks altogether. Even a celebrated pugilist adds his testimony to science, and says: "When it comes to business, give me dumb-bells and cold water."

Effect of Alcohol upon the Muscular Tissue.— If you could see under a microscope a piece of muscle taken from the body of a man who had been in the habit of indulging in intoxicating drinks before his death, you would find it pale and flabby and oily in appearance, instead of bright red and firm and elastic, as in a similar piece taken from a person in good health.

The reason for this is that repeated alcoholic drinks, even though they be small and not enough to produce intoxication, cause little globules of fat to take the place of healthy muscle. This is what physicians call "fatty degeneration." A leading physician says that when alcoholic drinks are administered from the beginning to the end of a fever or chronic disease, or drunk in the form of beer, wine, or distilled spirits as a beverage, the harm done to the nerve-force and to the healthy growth of the tissues directly encourages fatty degeneration in almost every tissue in the body. Beer is distinctly an enemy to muscle. Thousands of beer-drinkers who, as young men, were strong and muscular, and who weighed about one hundred and fifty pounds, have added at least fifty

pounds of worthless fat to their bodies at the expense of their muscle. They look stout, bloated, and coarse, and their once firm muscles are soft and flabby.

Effect of Tobacco upon the Muscle.—The nicotine in tobacco paralyzes the nerves and makes them unable to control the muscles, so that cigarette smokers and those that use large quantities of tobacco have a slight tremor in the hands. Professor Oliver, when at the head of the Department of Drawing at West Point, said that he could invariably recognize the user of tobacco by his tremulous hand, and his "absolute inability to draw a clean straight line."

All football players, racers, and rowers, when in training, are forbidden the use of tobacco as well as alcoholic drinks, and so much importance is attached to this abstinence that, if it were known to one side that any man on the other side was breaking the rule, the total abstainers would feel sure of victory.

SYNOPSIS.

Function of Muscle—Power of moving parts of skeleton.

Description:

1. Red masses commonly called flesh.
2. Divisible into fibres.
3. Have the power of contracting or shortening.
4. Three kinds are:

a. Voluntary—Under control of the will—on outside of body.

1. Appear striped under the microscope.
2. End in tendons for attachment to bones.
3. In contracting, become shorter, thicker, broader, and harder.

b. Involuntary—not under control of the will—heart, walls of stomach, and arteries, etc.

1. Are not striped as seen under microscope.
2. No tendons.

c. Mixed—Consisting partly of voluntary, partly of involuntary fibres, such as muscles between the ribs.

5. More or less fat between the fibres, between the different muscles, and covering them.

6. Muscles usually occur in groups.

Uses of fat :

1. To keep the body warm.
2. To protect the body from pressure.
3. To serve as a food.
4. To improve the appearance of the body.

The Way in which muscles act :

1. Become shorter.
2. Become broader.
3. Become thicker.
4. Become harder.
5. Bring together the parts to which attached.
6. Dependent upon the influence of the brain, spinal cord, and nerves.
7. Ordinary muscular movements very complex.

Number of Muscles—About three hundred on each side.

Shape of Muscles—Varies greatly : Most frequently, long fleshy bundle ; flat, fan-shaped, square-shaped, circular, etc.

Size of Muscles—Varies greatly ; smallest, a fraction of an inch (found in ear) ; largest, over two feet in length (extends from hip-bone to leg).

A Few Important Muscles :

1. Biceps—Front of arm—bends forearm upon arm.
2. Triceps—Back of arm—straightens arm.
3. Pectoralis—Muscle of chest—draws arm across chest.
4. Diaphragm—Involuntary muscle separating abdomen from chest—muscle of breathing.
5. Tendon of Achilles—Just above heel—lower end of a large muscle of leg—has received its name from story concerning Achilles.

QUESTIONS.

1. What use do we make of muscles? 2. What does muscle-tissue look like? 3. What is it commonly called? 4. What are muscle-fibres? 5. What are tendons? 6. Of what use are tendons? 7. What can you say about the appearance and the strength of tendons? 8. How does fat occur with muscle? 9. What are the uses of fat in the body? 10. What proof is there that fat is used as nourishment by the blood? 11. Is there a larger proportion of fat in the baby or in the grown person? 12. What three kinds of muscle are there? 13. What is a voluntary muscle? 14. Give an example? 15. What is an involuntary muscle? 16. Give an example? 17. Why is it necessary that some muscles shall be involuntary? 18. Give an example of the working of an involuntary muscle. 19. Do muscles ever belong to both classes? 20. Give an example. 21. What do we mean when we say a muscle contracts? 22. How does the muscle change when it acts? 23. Can the muscles contract of their own accord? 24. What causes the muscle to act? 25. What part does the brain take in the contraction of muscles? 26. What part do the nerves take in this? 27. How can you prove that muscle itself cannot act without the influence of the nerves? 28. What two sets of muscles do we usually find together, and how does one set act toward the other? 29. Give an example of two muscles which have exactly opposite actions? 30. How are the different expressions of sorrow, joy, and the like produced in the face? 31. What may result from continually having an ugly or a foolish expression in the face? 32. How many muscles are there in the human body? 33. Do muscles usually occur singly, or are they usually the same on one side of the body as on the other? 34. Mention some of the shapes of muscles. 35. How do muscles vary in size? 36. Where is the *Biceps* muscle? 37. Describe the *Triceps* muscle. 38. Describe the *Diaphragm.* 39. Describe the *chest-muscle*, and give its other name. 40. Where is the *Tendon of Achilles?* 41. From what circumstance did it receive its name? 42. What effect do alcoholic drinks have upon the nerves that control the muscles? 43. What effect does beer have upon the tissue of the muscles? 44. What do scientific men say about the amount of muscular energy to be derived from alcohol? 45. How does tobacco affect the muscles?

CHAPTER V.

PHYSICAL EXERCISE.

The Value of Physical Exercise.—A "sound mind in a sound body" is of far more value than fame or riches. But few young people realize that it takes time and thought and work to develop their bodies to the greatest perfection. Fortunately, the natural desire of children to run and climb and play gives them, even in the city, an opportunity to exercise.

Every nation has its outdoor games which require its youths to excel in physical strength. Nearly every nation has some ball-game which develops the muscles of the arm in throwing, and the muscles of the leg in running. The English have cricket, the Canadians lacrosse, and the Americans base-ball.

The Greeks had a great festival once every four years, called the Olympic games, in which the young men ran races, jumped, threw quoits, called *discoboli*, and wrestled. The victors were crowned with laurel wreaths. In the same spot where the Olympic games took place 2,000 years ago, international games were recently held, and youths from all countries attended. Some of the first prizes were won by the young men who went from our American universities.

But although some of them excelled, the majority of the American youth is not up to the standard of the ancient Greeks. They considered the human body the most beautiful thing in the world, and they spared no pains to develop it. They had magnificent baths where everybody could bathe, and thus keep the skin clear and healthy; and they had

instructors to teach the young how to exercise. Their statues show how finely the muscles were developed, and how perfectly their bodies were proportioned.

In the Middle Ages jousts and tournaments were the form in which young men took their recreation and exercise ; but physical culture was neglected by the students. In the pictures and statues of monks and saints, we see men represented who were very thin and gaunt from fasting, over-study, and lack of exercise. A walk in a shaded cloister was all their daily recreation, and their bodies grew pale and emaciated.

Thus we have the two contrasts, the one all body and muscle and the other all mind. The sensible boy combines the care of his body with the development of his mind, and does not let either his sports or his studies take all of his time.

Girls are not, as a rule, as strong as boys, for they generally stop playing out of doors when they are about twelve years old, and, as a result, they are more apt to be pale and weak and to have headaches than boys. They need just as much exercise to make strong, healthy women. The coming of the bicycle for women will undoubtedly make the next generation stronger and healthier, for the short skirt and loose shirt-waist give a girl freedom of movement, and the exercise develops the muscles, fills the lungs, and takes the girl into the fresh air of the country and parks. Tennis and basket-ball, which are games particularly suited to girls, give the same free muscular movements that boys have.

Effect of Exercise on the Muscles.—Every time a muscle is used, some of the minute cells of which it is made up undergo a change. They cast off some waste material into the blood to be carried away by the skin or lungs or kidneys, and replace it by some new material brought by the blood from the food that has just been digested. The more the muscle is used the greater is the blood-supply brought to it, and the more rapidly are the old cells carried away and

replaced by new ones. Thus constant exercise makes a muscle grow.

A man whose daily work is wholly muscular develops very strong and large muscles, like the village blacksmith in Longfellow's poem,

> "The smith a mighty man was he,
> With strong and sinewy hands,
> And the muscles of his brawny arms
> Were strong as iron bands."

Yet if such a man were confined to his bed for a month, his muscles would shrink away and become soft, and when he got up he would hardly have strength to stand. Or if he broke his arm and was obliged to wear it in a sling for some time, when the splint was removed the arm would be small and shrunken and helpless compared with the well arm, and it would take much exercise to bring it back to normal size, so much do the muscles depend on exercise for their growth.

People whose work requires no bodily exercise, such as clerks, shop girls, factory workers, and all who do their work sitting down, have little or no muscular development. The muscles of the neck and shoulders are weak, so the head is bowed forward instead of being held erect. The muscles of the leg and foot are weak, so the step is ungraceful and dragging instead of light and springing.

Boys who have military drill, and girls who have calisthenic exercises are always well built and graceful. They walk and run and dance well, because their muscles are strong enough to support every part of the body equally.

Effect of too much Exercise upon the Muscles.— Exercise is the life of the muscles, and yet they may be exercised too much. When one climbs a high mountain with no previous exercise, or takes the first long swim of the summer, the muscles feel stiff and ache. This is a sign that they have been overworked. Every muscle has its limit beyond

which it cannot go. You may hold a book at arm's length for perhaps three or four minutes, then in spite of all your will-power the arm will drop because the muscles are exhausted. It is unwise to continue any exercise until the muscles have reached the limit of their endurance. When a feeling of fatigue comes it is a signal to rest.

Effect of Exercise on the Skin.—After running or taking any hard exercise, the skin is flushed, and becomes very warm, but on taking the temperature with a physician's thermometer it will be found to be just the same as it was before, about 98½° F. Nevertheless the skin *feels* much warmer. This is because the exercise has made the heart beat much faster, and it has pumped the blood into all the fine blood-vessels or capillaries that are spread out like a net under the skin. But just as food spread out over a plate cools quickly, so the blood spread so near the surface of the body is cooled as fast as it is heated.

With exercise comes perspiration, which oozes out from little glands all over the skin. When the body is bathed in it, the act of evaporating, or drying up the moisture, dissipates the heat from the skin, so that exercise not only heats and flushes the skin but at the same time provides a way to cool it off and keep the temperature even.

Experiments and experience have shown that during exercise a great deal of waste matter is carried away from the skin by means of perspiration. Such matter, if not carried off, clogs the skin, and makes it look oily and pimpled. This is why people who take plenty of exercise nearly always have clear complexions.

Effects of Exercise on the Lungs.—Bodily exercise, such as walking, running, climbing, and rowing, make it necessary to draw long, deep breaths, which grow faster and faster as the exercise increases. With each breath fresh air is taken in, and more Oxygen is received by the blood, while the impurities are more rapidly given off from it.

Large gymnasiums have an instrument called a spirometer, that tests the capacity of the lungs. One takes a long, deep breath and then blows the air out through a tube. An index needle then shows how many cubic inches of air there were in that one breath. If the chest is narrow and hollow the lungs will hold very little air, and the extreme ends of them will rarely be inflated. This renders them very delicate, and after a cold one may be in danger of contracting consumption or pneumonia.

Daily exercise will increase the capacity of the lungs and make them do better work. Walking with the head erect and drawing long, deep breaths through the nostrils, not through the mouth, as well as singing or reading aloud, are excellent exercises to make the lungs strong and healthy. But these cannot be accomplished if the clothing is tight, especially by girls who wear tight corsets, and who most of all need deep breathing. If the ribs are pressed in, as in Fig. 72, it is impossible to fill the lungs with a good breath.

Effect of Exercise on the Heart.—The contraction of the muscles of the body during exercise forces the blood more quickly to the heart, which in turn pumps it away more rapidly and in larger quantities all over the body. A person whose blood is always moving quickly is said to have a good circulation. He always feels warm ; but a person who has a poor circulation generally has cold, clammy hands and feet. Such people need to take more exercise to keep their blood moving.

When one is asleep the blood flows more slowly and the heart does not beat so often, therefore the temperature of the body falls a little, and we are obliged to cover ourselves up warmly to keep from feeling cold. It is a good thing to take a few moments brisk exercise on waking up in the morning to rouse the blood into action.

One must beware, however, of taking too violent exercise, for sometimes the heart is overtaxed, and men have often been

known to fall in a faint, and sometimes to die at the end of a race. A boy often injures his heart, though he may not know it at the time, by violent running; for the excessive exercise gives the muscles of the heart more work to do than is natural and the heart becomes enlarged by the strain, and all through his after life is weaker.

Effect of Exercise on the Appetite.—Exercise in the open air is the best tonic one can have. As fast as the waste matter of the various tissues is thrown off by the skin and lungs, there is a demand upon the blood for more material to build them up. The blood cannot supply this unless plenty of food is put into the stomach. The need of this food is made known to a person by the feeling of hunger. When a person takes no exercise he does not wear out so many cells, therefore the stomach gets no message demanding food, and he says he has no appetite. But after a few hours hard exercise the food, which before he did not relish, now tastes delicious to him, because every part of his body is crying for the blood to bring it new material. The faster this wearing out and building up of the cells of the body goes on the better a person feels. Therefore a good appetite following exercise is a sign of health.

When to Exercise.—It is not wise to exercise just after a hearty meal, for the stomach needs the blood in its walls to help it secrete the juices that digest the food, and if it is then driven rapidly through the body and out to the skin, one is apt to have a badly digested dinner and an attack of dyspepsia. Nature provides against exercise after eating by making us feel very sleepy and lazy, so that the stomach may have the use of most of the blood.

Neither is it wise to take severe exercise in the early morning before breakfast, for the body is not so strong as it is after it has had food. Still, one may take a walk or a bicycle ride if one has taken a little something to eat first. Many people, however, feel exhausted all day if they exercise before breakfast. In such cases another hour is better.

For the student the afternoon hours are the best, for his brain is tired with a long morning's attention. It is a good plan while studying to break the time; for instance, after studying for an hour to get up and take a brisk run, and then come back to work.

It is always wise to exercise after bathing, whether it be after the daily sponge bath, a warm bath or open-air bathing, for the water chills the skin and drives the blood away, and exercise brings it back and makes the skin glow.

One needs more exercise in winter than in summer. The inhabitants of very hot countries generally sleep in the middle of the day, while in cold countries they are far more active and energetic, because they feel the need of keeping their blood in constant circulation.

One should always stop exercising when the body begins to feel slightly tired, for exhausted muscles do not react quickly.

Different Kinds of Exercise.—The story is told of a man who was not feeling well and who consulted a physician. "Exercise is what you need," was the prescription. "But, doctor," began the man.

"No excuses," said the doctor; "a man cannot live without exercise."

"But, doctor, my business——"

"Never mind your business," said the doctor. "Do as I tell you. Go out into the open air and walk."

"But, doctor," the man finally managed to get out, "I am a postman."

Everybody needs to exercise the parts of his body that are not employed in his daily work. A man who walks all day would find rest by exercising his brain in reading, or by using his hands, as, for instance, playing an instrument or carving wood.

The woman who sews, or carries children, or runs a sewing machine is rested by a walk; though the ideal exercise

for her, if it were possible, is rowing, as it strengthens the chest and throws the shoulders back.

The man who sits all day at a desk finds relief in walking, swimming, riding a wheel or working in a gymnasium.

Many brain-workers take exercise by doing something with their hands, as a little carpentering or gardening; and the well-known story is told of England's great statesman, Gladstone, that he felled oaks for his morning's exercise.

The kind of exercise that each one can take depends largely on his circumstances and surroundings, but all physicians agree that out-door exercise is the best, and that exercise which takes the form of pleasure is better than that which is a duty. Therefore, every game is to be recommended: foot-ball, base-ball, croquet, tennis, boxing, fencing, golf, jumping rope, and all running games, as well as all such sports as horse-back riding, rowing, swimming, dancing, and bicycling. But in every one of them it must be remembered that there is danger if it is carried to the point where rest does not come quickly after fatigue, for that shows that the muscles have passed their limit of endurance.

Gymnasium Exercise.—An hour several times a week spent in a gymnasium, under the direction of an instructor, will develop the muscles more evenly than any other form of exercise. Anyone can add, by a few weeks' practice, an inch to the biceps and many cubic inches to the lung capacity.

But if there is no gymnasium connected with the school, there should be some form of calisthenic exercise taken in the school-room. It is there that the muscles grow cramped and the life and vim are taken out of the children. Such exercise is more stimulating and restful if accompanied by music, as the close attention required for very precise exercises does not refresh the body. Some of the simple, well-established exercises, such as any teacher can direct, will, if used for five or ten minutes twice a day, do much toward relieving the tired feeling that school-children get, and developing a

symmetrical figure. Exercises for the head and shoulders correct the tendency to stoop, exercises with the arms expand the chest, exercises for the spinal column keep the spinal column straight, and exercises for the feet keep the hips even. In addition to this, constant attention by the teacher to sitting straight and standing firmly on both feet will make the figure erect and graceful.

Home Exercise.—Simple apparatus can be arranged at home with little expense which, if regularly used, is a great help toward muscular development and general health. Dumb-bells or Indian clubs, if used for ten minutes, will put one all in a glow. Pulley apparatus is excellent; but even without any apparatus one can find some way to exercise. The transom of a door serves as a bar to pull one's self up by. A chair laid on the floor may be used as a support to raise and lower the body by the arms for a chest exercise.

The exercise of lying flat on the floor or bed with the arms folded and of raising one's self to a sitting posture, or standing with the arms raised and bowing without bending the knees until the hands touch the floor; or of jumping and crossing the feet, at the same time touching the hands over the head; all these make a good substitute for gymnasium work.

Effect of Alcohol and Tobacco upon Athletes.—The practical testimony of all athletes is against the use of alcohol and tobacco in any form, for they claim that it, in a large measure, counteracts the benefits that are to be derived from the exercise.

In the great boat races between Oxford and Cambridge in England, and between Harvard and Columbia and other universities in this country, the men who row are required to go into training for a certain number of months beforehand. The great foot-ball teams of the country are also required to "train" before games. In order to get their muscles into the strongest and most elastic condition they are obliged to

live an ideally healthy life. They must exercise regularly, go early to bed and sleep a certain number of hours. They must eat only the most digestible and healthful food, no pastry or confectionery, and, above all, they *must not touch alcohol or tobacco in any form whatsoever.* When the day of the game or the race comes they have cool, steady nerves, muscles like iron, and well-developed bodies in which there is not an ounce of superfluous fat.

"Any man," says Dr. Martin, in speaking of college athletics, "who, after election as a member of his college crew, should be found secretly drinking beer or smoking, would be hissed out of college."

Hanlon, the famous oarsman, says: "In my opinion, the best physical performance can be secured only through absolute abstinence from alcohol and tobacco. This is my rule, and I find that after three years' constant work at the oar, during which I have rowed many notable match races, that I am better able to contend than when I commenced. In fact, I believe that the use of liquors and tobacco has a very serious effect upon the system of the athlete."

SYNOPSIS.

The value of physical exercise.

Games of different nations: English.
Canadian.
American.
Grecian.

Contrast between the ideas of the ancient Greeks and the monks of the Middle Ages concerning the care of the body.

Ideal combination, body and mind, play and study.

Effect of exercise on muscles: Replace worn-out cells.
To increase the size of muscle.

Lack of exercise: Through sickness, great weakness.
Through broken limb, thin and shrunken.

Too much exercise: Fatigue.
Through daily occupation.

Effect of exercise on the skin :
Feeling of heat.
Perspiration.
Removal of waste matter, making it clear.
Effect of exercise on the lungs :
Breaths come faster, breaths are deeper.
Increases capacity, beneficial exercises.
Effect of exercise on the heart :
Rapid beating.
Good circulation.
Less heat during sleep.
Danger of overtaxing heart.
Effect of exercise on the appetite : By carrying off impurities faster, cells demand more blood, which demands more food from stomach.
Appetite a sign of health.
When to exercise : Not after eating.
Not before breakfast.
Afternoon for students.
After bathing.
More in winter.
Stop when tired.
Different kinds of exercise : According to occupation.
Men who walk.
Desk workers.
Brain workers.
Women in various occupations.
Out-door sports and games the best.
Gymnasium exercise : Advantage for symmetrical development.
School exercise.
Home exercise : With apparatus.
Without it.

QUESTIONS.

1. Of what value is physical exercise? 2. What is the natural way for children to take exercise? 3. Mention the ball-games of different nations and tell how they develop the body. 4. Describe the Olympic games of the Greeks. 5. How do young men of to-day

compare with the ancient Greeks? 6. How did the Greeks treat their bodies? 7. How did the monks of the Middle Ages treat their bodies? 8. What is the sensible course between these two methods? 9. Why are girls seldom as strong as boys? 10. What is the advantage of the bicycle for women? 11. What is the effect of exercise on the cells of the muscles? 12. Explain how exercise makes a muscle grow. 13. How does staying in bed affect the muscles of a strong man? 14. What is the effect of not using a limb? 15. Give an example. 16. Describe how the lack of bodily exercise affects a person's walk and figure. 17. What effect do military drill and calisthenic exercise have on the figure? 18. Can a muscle get too much exercise? 19. How? 20. What is the sign that a muscle has been overworked? 21. What is the normal temperature of the body? 22. Why does the skin feel hot after exercise? 23. How does perspiration cool the skin? 24. Why does exercise make the skin fresh and clear? 25. What effect does exercise have on the breathing? 26. What benefit is there in long deep breaths? 27. How can you test the lung capacity? 28. What danger is there in a narrow chest? 29. How can one increase the capacity of the lungs? 30. How do corsets affect the lungs? 31. How does exercise affect the heart? 32. What is meant by a good circulation? 33. What are the signs of it? 84. What effect does the heart have on the heat of the body? 35. Why is a little exercise good in the morning? 36. What bad effects do too much exercise have on the heart? 37. How may a boy injure his heart? 38. Explain how exercise acts as a tonic. 39. Why does one have such a keen appetite after exercising? 40. Why is a good appetite a sign of health? 41. Why is it not wise to exercise after a hearty meal? 42. How does Nature provide for a rest for the stomach? 43. Why is it not so wise to exercise before breakfast? 44. What is the testimony of athletes concerning the use of tobacco and alcohol? 45. What is required of all foot-ball players and college crews? 46. What are the men required to do when they are training? 47. What effect does the training have on their bodies? 48. How would students regard anyone who broke the rules while training? 49. What is Hanlon's testimony against the use of tobacco and alcohol?

CHAPTER VI.

FOOD AND DRINK.

In a mountain lake, though the water is constantly flowing out at one end, the lake does not disappear, because there is always more water flowing in at the other end, or bubbling up beneath it in springs. It may be a little higher after a melting snow or a heavy rain, or a little lower in a dry season, but it remains at about the same level, and yet the drops of water in it are never twice the same.

This is true of our bodies, which are made up of an infinite number of separate cells. The body sometimes is a little thinner, sometimes a little fatter, but it looks the same. Even after twenty years one does not find a friend very much changed. And yet the body is constantly changing. Like the lake, there is always waste matter being given off, and always new food material being taken in. If the inlet of a lake were stopped it would take only a short time for all the water to drain off, leaving only a muddy marsh. If the food and drink that go into our bodies were stopped it would take only four or five days before life would stop, though if water alone were given the body could live for several weeks, but it would be very feeble.

The food does not go directly in the form of milk or bread to build up each cell, but it is changed into blood which circulates in every part. From it each cell takes what it needs, lime for the bone cells, iron for the blood-cells, and digested sugar and starches for the fat-cells. At the same time all the useless material of old, dead cells is cast into the blood and gotten rid of, by being passed off by means of the

skin in perspiration, or the lungs in the form of breath; or by means of the kidneys or intestines.

Every day, if we are in good health, we pass away on an average about three pints of waste material from the kidneys or intestines; a little more than half a pint from the intestines; about one and two-third pints from the skin in the form of perspiration, which we do not always notice, and a little over two pints in the moisture of the breath. In all nearly four quarts, of which a very large proportion is water.

In order to keep the inlet equal to the outlet, there should be more than four quarts of food and water taken into the body each day. Children have less waste than older people, although they generally eat more, for they add more food material to their cells to make their bones, and muscles, and other parts grow. After a person reaches sixteen or eighteen years of age, growth in height usually stops, though growth in weight and size continues until the age of twenty-five, and sometimes much longer. But a grown person who is well generally gains or loses but a few pounds in many years. If he eats or drinks more than he needs to make up for the waste of his body, the surplus as a rule takes the form of fat.

Food is anything that nourishes us and helps to build up the cells of the body. Strictly speaking, air is food, for it is essential to life, and the Oxygen which is in it forms sixty-two and a half per cent. of our bodies, but we do not get it directly from the air, but in a roundabout way. What we generally mean by food is the water, the meat, the fruit, and vegetables, etc., that we eat. These, however, are only the *forms* in which the food appears, for the real food is the four chief elements, Oxygen, Hydrogen, Nitrogen, and Carbon, which, with some of the minerals, make up everything we eat. We never see these elements in the air or in food, because they are rarely found free, but they are always combined to form some familiar article of food or drink. Chemists tell us that every drop of water may be separated into Oxygen and

Hydrogen, and as water forms a large proportion of all fruits and vegetables, as well as milk, we eat considerable Hydrogen and Oxygen in such foods. The starch which forms so large a part of all flour and grain foods can be separated into Carbon, Oxygen, and Hydrogen, hence these foods are called Carbohydrates. Meat has Nitrogen as well as other elements.

It would seem a very easy way to live if we could get these four elements with some minerals directly from the air and water. It would save growing vegetables, slaughtering animals, and much cooking, but the plants are the only living things that are so constructed that they can take food in this raw or crude form. The roots suck in minerals and Nitrogen in the form of salts which are dissolved in water. By means of their leaves, spread out in the sunlight, they can take just the right proportion of Carbon and Oxygen to unite with the Hydrogen and Oxygen of the water in their sap, and turn them into starch.

Much of this vegetable food we cannot eat unless it is turned into other forms of foods by animals. Our stomachs cannot digest hay, but a cow's can, while we eat the beef and milk that are made out of the digested hay. Grass would make us sick, but a sheep can turn it into excellent mutton. We could not digest hard kernels of corn or grains of wheat, but we find much nourishment in the chickens fed on such a diet. Thus all foods come originally from the air and water and soil, but are worked over by plants and animals into the form of vegetables and meats.

Different Kinds of Foods.—All foods, whatever their form, may be classified in four groups according to the relative proportion of Oxygen, Hydrogen, Nitrogen, and Carbon or other elements that each contain.

These are: 1. Proteids.
2. Starches and Sugars.
3. Fats and Oils.
4. Mineral Foods, water, salt, etc.

Proteids.—A large part of the cells of the body are made up of living protoplasm. The proteids are the class of food that nourishes the protoplasm. They are the foods in which Nitrogen is found. They are found in all meats, in fish, oysters, eggs, milk, and in many cereals. Peas and beans have almost as much proteid material as beef. These foods build up the muscles as fast as they are worn down; they make the blood red; they give strength to the body; and without a certain proportion of this class of food it cannot live.

Milk.—Milk is the first food that a baby can take. It has all the different kinds of food-stuffs in about the following proportions:

	Per cent.
Proteid	4
Fat (cream)	4½
Sugar (no starch)	5
Mineral matter	½
Water	86

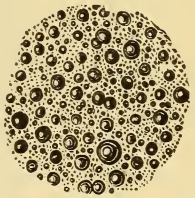


Fig. 33.—A Drop of Milk Seen under the Microscope, Showing the Fat-globules (Cream).

It takes about four quarts of milk a day to feed a grown man. In sickness people often live on milk for weeks. It is very easily digested and is nearly all converted into blood, there being very little waste. For this reason, in health, one needs to eat bread or some starchy food with the milk to give bulk to the waste matter.

Milk sours easily; that is to say, bacteria grow in it rapidly if the temperature is warm, and cause it to ferment. It is then very unfit for food, and in this condition will make a baby very sick with summer complaint. In hot weather the milk should always be heated until it steams (not boils) before it is given to an infant. The heat kills the bacteria.

Meat.—Tender meat is made up almost wholly of muscle. It is the connective-tissue and fibres of older animals that make it tough. Beef has twenty per cent. proteid matter, and nearly eighty per cent. water. Very little of this

proteid matter is wasted; but about one-fifth of the proteid matter in peas and beans go to waste. Meat decays easily, for bacteria attack it readily. Butchers hang meat for several weeks in an ice-room to keep it fresh while it is growing tender. Meat in the country is very apt to be tough because it is eaten so soon after it is killed. Soups made of the bone and meat are very nourishing, but beef-tea contains hardly any of the proteid matter of the beef; it consists chiefly of the salts or mineral portion, which is very slight, but which nevertheless serve as a stimulant, and takes the place of more solid nourishment in sickness. Smoked and dried and salted meats will keep a long time, but the fibres are toughened and hardened, and the gastric juice cannot digest them so easily.

Fats and Oils.—The fats are more completely absorbed in our system than any other kind of food, even meat. They are of use in keeping the body warm. The colder the weather the more we like fat foods, such as sausages, pork, and suet puddings. Esquimaux children suck blubber, or whale-fat, as our children would candy, because their bodies crave it in their very cold climates. Some animals, like the bear and badger, that sleep all winter, crawl into their holes very fat, and come out very thin. The fat that is stored up in their bodies in some way is reabsorbed by the tissues and keeps them from needing food. If we eat plenty of fat meat, cream, butter, and food with suet, lard, or olive oil in it, there will be stored up in our bodies a reserve supply of fat that will be of service to us in time of sickness. People who have any wasting disease like consumption, or little children who are very thin, take cod-liver oil, because it is an easily digested fat and it quickly makes their bodies warm and healthy.

Starches and Sugars.—It is important to understand thoroughly what *starchy food* is. You may have seen starch used for stiffening linen. When used in this way, it is first mixed with water and then placed on the fire, which causes it to swell up and become changed into a paste. Raw starch

is not suitable for food for man ; it must first be made digestible by boiling. All starchy food must first be boiled before it can be used as food. The cow and ox can eat hay and oats and digest them ; but man could not think of taking oatmeal raw, but only after it had been boiled. The same applies to rice, farina, barley, and all other farinaceous food. There is no starch in fleshy food and none in animals ; it occurs only in plants.

If you scrape the inside of a potato with a wet knife, you

Fig. 34.—Starch Granules (from Potato) as Seen under the Microscope.

will get a cloudy, white fluid. Put a drop of this under a microscope and you will see a number of small things that look like oyster-shells. They are grains of starch. They cannot be digested by our stomachs until they are burst apart by being boiled or fermented. Then the saliva of the mouth and other juices of the intestinal tract turn them into sugar. The sugar of farinaceous or starchy food gives heat and energy to the body and makes healthy fat.

Bread is the staff of life in this country. But white bread is not so nourishing as the brown bread made out of the whole wheat flour. For in white bread nearly all the proteid

matter is removed with the husks, leaving nothing but starch; but in brown bread the proteid part, or the gluten, is ground up with the flour.

Vegetables and fruits contain some starch and sugars, but are chiefly water and cellular tissue. All grains are rich in starch, especially wheat, oats, and rice. But a great proportion of such diet goes to waste. This is a point in its favor instead of against it, for the stomach and intestines need bulk to work with, and the pulp of fruit and the undigested parts of corn and oatmeal and bread, together with the water we drink, push out and wash away all the worn-out parts of the tissues that the body wants to get rid of.

Mineral Food.—The commonest mineral food besides water is salt. All meat and bread and vegetables have a little of it naturally. We, ourselves, have each about half a pound in our bodies, but we are constantly losing some in perspiration; the supply, however, does not seem to give out, for no matter how many tears we shed, the last are always as salty as the first. Too much salty food produces a disease which affects soldiers and sailors, who cannot get fresh meat or vegetables. One could not live long without any salt, and because it is so necessary we always add a little to our food in cooking.

Other minerals occur in our food without our being aware of their presence. Some are dissolved in water and others appear in vegetables, and a very small proportion is found in meat. Celery is rich in potash and iron, and potash is found in lettuce. Both are wholesome and good for the blood. The salts of lime occur in water and in the bones of animals.

Water.—Our bodies are by weight about two-thirds water. The Egyptian mummies, even when they are the bodies of large men, are very light, because all the water has been dried out of them. About eight-tenths of all our food is water, either in the form of drinks, or in fruits and vegetables and meats.

Rain-water is pure and soft—that is, there are no minerals in it—but as it soaks through the earth it dissolves iron, salt, lime, sulphur, and various other minerals. When the water contains lime it is called hard, and is not good for washing, because it makes a scum, instead of a lather, with soap. It is, however, good to drink. When it contains much iron or sulphur, it is thought to be as good as medicine, and thousands

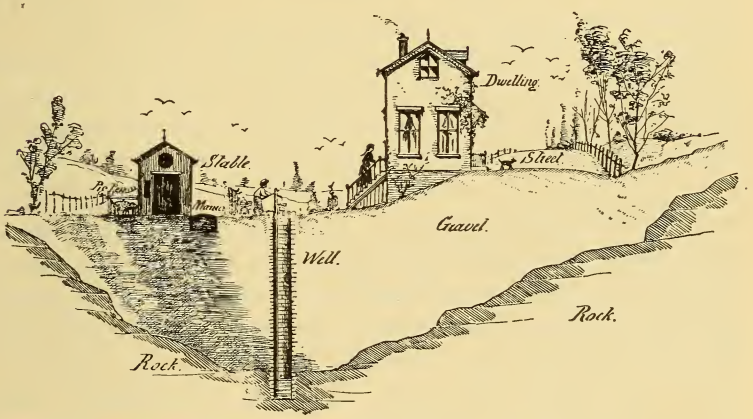


FIG. 35.—A Section of a Dwelling, and its Accompaniments, as is often Found in the Country. The shading extending from the stable to the layer of rock at the bottom of the well, shows the course of the poisonous material from the stable, with its manure-heap and pig-pen, to the well.

of people go every year to Saratoga and White Sulphur Springs to drink the mineral waters.

Impure water is often a cause of disease, and the Boards of Health of large cities take the greatest care that the lakes from which the city's drinking-water is drawn shall be perfectly pure. No stables or farms or cess-pools are allowed anywhere near the margins of such lakes, and no one is allowed to bathe in the waters. Bacteria live easily in water where there is any animal or vegetable matter, and the pure rain-water sinking through the soil contaminated by animal refuse, drains the impurities down with it to the lake.

Typhoid fever is nearly always contracted by drinking contaminated water.* The germs of the disease live and multiply very rapidly in water, and will remain a long time. People have even been known to get the disease by drinking milk out of cans that had been washed in well-water infected by typhoid bacteria. In villages where there is no drainage the soil often becomes so soaked with the germs of disease that the drinking-water is all affected, and so many people are sick that there is said to be an epidemic. Clear water is not always pure. Water may be very impure and still be very clear and transparent. And again, water may look a little cloudy, and yet be perfectly innocent and healthy. What makes some water unhealthy and injurious are impurities taken from the soil; in the country, where the water from *wells* is used, such impurities are often present. In the country very often no other water can be obtained except that from the well, and for the sake of convenience, the well is built near the house, stable, and other outbuildings, where it is very apt to be poisoned. Fig. 35 illustrates very nicely the manner in which the well-water may become poisoned. It is a good example of what occurs constantly in many places in the country where well-water is used without proper precautions having been taken to prevent poisoning.

An examination of the picture on p. 85 shows the following: To the right is the dwelling-house, with the outhouse near by; to the left is the stable, with its manure-heap and pig-pen; between these two is the well. The surface of the ground is fairly level, and is sandy, and beneath this is gravel. The rain soaks into the porous ground, and in doing so dissolves poisonous matters from the manure-heap and the pig-pen, and after it has soaked into the ground it remains there, since there is a layer of rock below which will not allow the water to pass. This poisoned water collects here, and then

* Recent experiences have shown that typhoid-fever germs are also carried by flies.

gradually enters the lower part of the well. When water is drawn from the well it will be easily understood that it is partly the same water which has passed over and through the manure-heap and the dirt of the pig-pen before passing into the ground. The shading extending, on the figure, from the stable to the bottom of the well, shows the course which this poisoned water takes. Such water often causes typhoid fever and other diseases.

It has often happened that a great many persons became sick in a village at the same time. When a great many persons become sick at the same time, and have the same disease, an *epidemic* is said to exist. Many epidemics have been found to have been produced by the drinking of poisoned well-water.

The water of a *pure river* should be preferred to that of a well. But sometimes we have no choice and must drink well-water. In this case we should see that the well is thirty feet or more from any inhabited building, and that no refuse or slops of any kind are allowed to soak into the ground. Such refuse should be kept in water-tight barrels and carted off regularly. If we are in doubt about whether the water is good or not, we may *boil it* thoroughly; this destroys the poison, and then we are safe in drinking it. Varieties of filters are made which are of value in freeing water from dangerous impurities; not all filters, however, accomplish this purpose.

Water which has stood in leaden pipes all night dissolves a little of the lead; hence when we use the water in the morning, we should allow it to run a few minutes.

Advantages of a Mixed Diet.—Scientific men tell us that a race that eats a great variety of food has more brain-power and more endurance than a race that eats only a few kinds. Some races and people eat vegetables only and are called Vegetarians, but they have to eat eggs and butter and milk, which are animal products, to give them proteids to

build up the protoplasm of their bodies. Such people are almost invariably better and stronger if they add meat to their diet.

Milk is the one food which contains all the different elements so combined as to make a perfect food in itself; but experience has taught us what foods to eat together so that we can get the variety that the body needs in one dish or in one meal.

To potatoes (starch), we add butter (fat) and salt (mineral), and eat them with meat (proteid); then we take something sweet (sugar) for dessert. To bread (starch) we add butter (fat). With crackers, and maccaroni (starch) we eat cheese (proteid). With eggs (proteid) we eat toast (starch) and butter (fat).

The character of man's teeth and the length of his intestines prove that man was not intended to live on a vegetable diet alone. His canine teeth are shaped somewhat like those of the carnivora or flesh-eating animals, and the intestines are neither so long as those of the herbivora or vegetable-eating animals, nor so short as those of the flesh-eating animals.

The carnivora, or animals that live on flesh alone, such as the lion, the cat and dog, have long, sharp-pointed teeth to tear their food, and short intestines. The herbivora, or animals that eat grass and herbs, such as the cow and sheep, have no canine teeth, and have very long intestines. Man has canine teeth which are not so long as those in the carnivora, and the length of his intestines is about half way between those of the carnivora and herbivora; therefore, he is especially fitted to eat a mixed diet.

Cooking.—Civilized men cook nearly all their food, and the more highly they are civilized the better do they make it taste. Oysters, milk, eggs, and some fruits and vegetables are the only kinds of foods that we find palatable when eaten raw.

The value of cooking meat is that the fibres are softened and it is made more tender and, therefore, easier to chew and digest. Broiling or roasting is the best and most palatable way of cooking meat, for all the juices are then retained. Boiling is adapted to all grains and vegetables that contain starch, for it softens them and bursts open the starch-grains, which cannot be digested raw, and makes it easy for the juices of the intestines to take hold of them.

Cooking combines different food-stuffs, as eggs, flour, milk, and sugar in cake; rice, milk, and raisins in pudding. It brings out with seasonings the best taste in foods, so that the appetite is stimulated and the saliva flows freely and aids digestion. Cooking kills all germs in food. It also tends to preserve meats, fruits, and vegetables which would not otherwise keep fresh.

BEVERAGES.

Coffee.—Most of the coffee used in this country comes from the West and East Indies, Arabia, and South America. The part of the plant used is the berry. The berries are dried and roasted, thus developing the aroma. The roasted coffee "beans" are ground; then boiling water is poured upon them and the whole mixture allowed to boil for a minute or two, making a decoction. This process extracts the caffein, coloring matter, flavor, and a very small quantity of nutritious matter.

Some persons cannot drink coffee at all; in such cases it has a peculiar and disagreeable effect and causes nervousness, trembling, headache, indigestion, palpitation of the heart, and wakefulness at night.

Tea.—The tea-plant is cultivated principally in China, Japan, and the East Indies. To prepare tea, boiling water is poured upon a small quantity of tea-leaves, forming an infusion; it must not be boiled, for this drives off the agreeable flavor with the steam, and dissolves too much of a bitter and

astringent agent in the water, which is called tannin. The active principle of tea is identical with that of coffee. Many people so depend on the reviving effect of tea that they cannot get through the day without a cup. They are then victims of a habit which is like the alcohol habit, only not nearly so injurious. Children who drink tea and coffee become sallow in complexion, and nervous. The bad effects of tea are more marked than coffee. It leaves a sense of depression after the refreshing stimulus has worn off, and the tannin gradually acts upon the walls of the intestines so that they do not secrete properly, thus causing chronic constipation. Few people will believe that their headaches, or difficulties with the digestion, are due to tea-drinking, for they argue that they are no better on the days that they do not drink it than when they take it; but such troubles are the result of many years' habit, and the system will not recover its tone sometimes under months. It is therefore much better for young people not to form the habit of drinking either tea or coffee, for people who dispense with its use altogether are almost invariably less nervous and have better digestions than those who drink these beverages every day.

There are many kinds of tea, and many mixtures are made to conform to different tastes. Green tea is sometimes used; this variety is apt to be injurious, especially in the production of nervous symptoms.

Cocoa and Chocolate.—The cocoa-tree is a native of tropical America. The seeds contain a principle identical with that found in coffee and tea; in addition they are very rich in nutriment, consisting of about one-half vegetable fat. Cocoa is prepared like coffee by making a decoction of the ground seeds. Chocolate is cocoa which has been ground up with sugar and certain flavoring agents. Both cocoa and chocolate are desirable drinks; they are more nutritious than either tea or coffee, and less liable to cause undesirable effects. For these reasons they should receive preference

over tea and coffee as beverages for children, though constipation is sometimes due to chocolate drinking.

Kola.—Of late years there has been imported from Africa a nut called the kola-nut. From it is made a drink called kola. It contains the same active principle—caffein, that is found in tea, coffee, and cocoa, and in about the same proportion as in coffee. When taken alone it makes a poor substitute for coffee, and when combined, as it usually is, with weak wine, it has a bad effect on the human system.

Coca-leaves and Cocaine.—Another very harmful drink which has obtained use of late years is made from the leaf of the coca-plant, a small, bushy shrub, found and cultivated in certain parts of South America. This must not be confounded with cocoa, the bean from which chocolate is made. The coca-leaf was first heard of through travellers in South America, who gave very graphic accounts of the marvellous powers of this agent in enabling the natives to endure physical hardships, not only sustaining their strength and giving them powers of endurance, but postponing the feeling of hunger.

These accounts were great exaggerations, since no such wonderful effects follow the use of the leaves as observed in this country. But as there is a very serious objection to the use of coca preparations, and since other harmless remedies will accomplish similar results, preparations of coca-leaves are objectionable.

Cocaine.—The effects of the coca-leaves are due to the existence of an active principle known as cocaine; this is obtained in small white crystals. When taken internally, cocaine acts as the coca-leaves from which it is extracted. But when applied externally cocaine has a wonderful effect upon tissues with which it comes in contact: it benumbs the small nerves which carry the sensations of feeling and of pain; and in this way the part to which it is applied loses all sensation.

The Cocaine Habit.—But the use of cocaine is at-

tended with very serious, and even fatal, results. Quite a number of persons have acquired the habit of taking cocaine, and have become slaves to it. In some of these cases the cocaine was given for the cure of the alcohol and the morphine habit; usually it has failed to cure these habits, and the unfortunate victims have simply had the cocaine habit added to the others. As a rule the drug is originally taken to relieve exhaustion and to exhilarate; an appetite for cocaine is then established, and larger and larger doses are required to satisfy it. The habit becomes firmly attached and produces disastrous results upon mind and body.

Similar results may follow the habitual use of "wine of coca," a preparation in which the active parts of the coca-leaves are dissolved in wine. The careless and frequent indulgence in this intoxicant not only tends to produce the coca habit, but favors the alcohol habit as well. The victim of the coca habit is as badly off as the drunkard.

SYNOPSIS.

Uses of Food:
- Indirect method of getting into body.
- Amount of water in food and body.
- Elementary composition of foods.
  1. Hydrogen.
  2. Carbon.
  3. Oxygen.
  4. Nitrogen and minerals.

Kinds of foods:
1. Proteids.
2. Carbohydrates.
3. Fats and oils.
4. Minerals.

Proteids:
- Milk, meat, eggs, etc.

Fats and oils:
- Butter, olive-oil, etc.

Carbohydrates :
Starches and sugars.
Mineral foods :
Salt, phosphates, iron, lime.
Water :
Should be pure.
Water that looks clear not always pure.
Dangers of typhoid fever in water.
Contaminated soil.
Advantages of mixed diet.
The reasons why man uses a mixed diet :
Teeth of both kinds, to tear meat and chew vegetables.
Length of intestinal canal to digest mixed diet.
Cooking.
Beverages :
Coffee, tea, cocoa, chocolate, kola, coca, cocaine and wines of coca.

QUESTIONS.

1. Why must we take food and drink? 2. What must happen to the food before it can be changed into our tissues? 3. Describe the food upon which plants live. 4. Do all animals have the same kind of food? 5. What difference is there between the kind of food which the cow takes and that which the dog eats? 6. What is meant by a carnivorous animal? 7. What is meant by an herbivorous animal? 8. To which class does man belong? 9. What is meant by fleshy food? 10. What is meant by vegetable food? 11. What is farinaceous food? 12. What is starch? 13. Do we find starch in animals? 14. Why is it necessary to eat green vegetables? 15. Do we need fat in our food? 16. Can man exist on any one form of food alone? 17. Why do we naturally eat butter with our bread? 18. How is bread prepared? 19. Why is yeast added? 20. Could we exist on milk alone? 21. Why? 22. What part of the milk does the cream represent? 23. What is butter? 24. What is cheese? 25. What can you say about eggs as food? 26. Could we eat the same kind of food every day? 27. What follows when we eat improper food? 28. Why is most of our food cooked? 29. Name some of the different plans of cooking food. 30. What makes

our drinking-water unhealthy? 31. Explain how well-water is often poisoned. 32. How can you prevent poisoning of well-water? 33. Name the various kinds of foods and in what respects they differ. 34. What are the advantages of a mixed diet? 35. Why cannot the human body live on vegetables like grass as the cow does? 36. What are the dangers of coffee and tea drinking? 37. What are the great dangers of coca preparations?

CHAPTER VII.

ALCOHOLIC DRINKS.

Besides tea and coffee and cocoa, there is a class of beverages in common use whose origin and nature have not been generally understood, and whose effect upon the health, character, and attainments of mankind have been very deplorable. These are the alcoholic drinks, the most common of which are beer, wine, and cider, whiskey, gin, rum, and brandy.

Alcoholic drinks are produced from fruits and grains by a process of fermentation. It is important to understand what fermentation is in order to see how fruits and grains which are good for food can be made to yield drinks that contain poison instead of food.

Fermentation.—Men have known for thousands of years that if they let a sweet, watery fluid stand in warm air for a certain length of time it would ferment and form alcohol. It is only within the last few years that we have found, by means of the microscope, the cause of this change.

Clinging to the stems and surfaces of the fruit from which the juice is pressed out to make wine, are the germs of various minute forms of life. Among them are germs that produce different kinds of molds and those that produce alcoholic fermentation. These last are called ferment germs.

When fruits are crushed and their juices pressed out to make wine, some of the ferment germs on their surfaces are washed into the juice and carried with it into the vats. Here the ferments begin to grow and increase rapidly in numbers, taking for their nourishment the oxygen that is contained in

the sugar of the juice. This breaks up the sugar and causes two new substances to form in its place—carbonic acid gas, which rises to the top in tiny bubbles, and alcohol, a poison, which remains in the liquid. It is the alcohol produced in a sweet liquid by fermentation that changes a healthful fruit juice to a dangerous drink.

Alcohol.—Alcohol is a poison which is capable of injuring all the tissues and organs of the body with which it comes in contact, and when taken in sufficient quantity, of causing death. When we say that a man is intoxicated, we mean that he is poisoned; the word "intoxicated" comes from a Latin word, "toxic," which means poison.

The Alcoholic Appetite.—Aside from being a poison, alcohol has the dangerous power of causing a diseased craving for more, which has been called the alcoholic appetite, or alcoholic thirst. This craving is very different from a normal or healthy appetite. A healthy appetite is satisfied with food and natural drinks. After a person has eaten enough of the right kind to fill his stomach comfortably, he does not care to eat any more. This is not the case with alcoholic drinks, for they have the power of making the drinker crave more and more, even when he knows they are doing him injury; and when he has gotten past the stage where he knows what he is doing, nothing seems to satisfy him.

Fermentation can be Prevented.—When a housewife boils the juice of currants or grapes, with an equal amount of sugar, she gets a thick, syrupy mass, which when cooled forms a solid jelly. This she can set away for months without covering it, and it will not spoil. Sometimes a little green mold will form on top of it, but because the jelly is solid and very sweet, the germs of mold and fermentation cannot grow through it. When she puts up canned fruit she adds only a little sugar, boils the fruit to kill the germs that are on the surface, and seals it while boiling hot in air-tight jars to prevent other germs from getting into it from the air.

Fermentation in Bread-making.—The yeast which the cook puts into bread-dough to make it rise contains many little ferment germs much like those that cause fermentation in fruit-juices. In the flour of which bread is made there exists a certain amount of free sugar which, dissolved in the moist dough, is broken up into carbonic acid gas and alcohol by the ferments of the yeast. The gas puffs up the dough and makes the bread light. The alcohol escapes in the oven

Fig. 73.—Yeast Cells, Showing Stages in Division of the same Cell.

while the bread is baking, so that there is no alcohol in well-baked bread.

Cider.—Cider is apple-juice squeezed out by a press and allowed to ferment. Often all the old wormy apples and windfalls that are not good for anything else are used for cider. Sweet cider is supposed to contain no alcohol, but this is the case for only about six hours. The germs which were on the stems and surfaces of the apples, and were carried into the juice as it was pressed out, soon begin to grow. There is generally a little of the fermented juice left in the

press from the day before containing additional ferments in an active state, which hastens the fermentation. In two or three days after being pressed out, if kept where it is moderately warm, cider has about two per cent. of alcohol in it, in a week about five per cent.; and as each day passes the amount increases, and those who drink it, as it gradually grows harder, cultivate a liking for a greater and greater amount of alcohol, until at the end of three or four weeks they are taking a drink which may contain fully ten per cent. of this poison.

The history of many a village in New England witnesses the truth of the following paragraph by Horace Greeley:

"I estimate that a barrel of apples was grown in New Hampshire a century ago with less care and labor than are now required to produce a peck. There being no market for the fruit (seldom grafted), cider was very abundant and very cheap. I have known it in excess at $1.00 a barrel within the last fifty years. It was of course the common beverage for the last three months of the year, and with thrifty people for at least half the year, a century ago. The farmer returning from his daily toil ate his supper and sat down by his fireside to talk and drink through the evening. Mug after mug of cider was drawn, and everybody felt a sense of exhilaration. The boys who graduated from those firesides too often evinced, at an early age, an insatiable appetite for stimulants, an appetite created, but by no means satisfied, by cider; and an appetite that very often consigned them to early and unhonored graves. I have known whole families to be burned out and the farm sacrificed by the fiery thirst, palpably generated by sucking and soaking around the family cider barrel."

Wine.—Wines are made from the juice of grapes or some fruit that has a great deal of sweet juice. This is pressed out and allowed to ferment. There are always some little germs clinging to the skin of ripening grapes, but they

cannot get at the juice unless the skin is broken. When the juice is pressed out of the grapes to make wine, the ferments are washed off into the juice and carried into the vat. There they go on growing and changing the sugar of the juice until enough alcohol is produced to give the wine the strength that the maker desires. When the alcohol reaches fourteen per cent. it kills the germs that made it, so that wine cannot have more than about that amount unless some is added to it.

Champagne and Effervescent Wines are not fermented in the open air, but in closed bottles, so that the carbonic acid gas produced by the fermentation is kept in with the alcohol and makes the wine sparkle and sting.

Many housekeepers make home-made wines out of currants, gooseberries, cherries, or blackberries. They often say with pride, "You needn't be afraid of this, I made it myself, and I did not put a drop of alcohol in it." This shows their ignorance of the fact that whenever fruit-juices are allowed to ferment their sugar will be wholly or in part changed to alcohol. Home-made wines often contain as much alcohol as the wines of commerce, and are then just as harmful.

Light wines are those that contain a small per cent. of alcohol. People often argue that the use of these wines, especially in wine-making countries, prevents people from drinking more intoxicating beverages; but others, who have seen for themselves the effects of these wines, say that in some wine-making districts, at the time of the vintage, everybody in the neighborhood—men, women, and even little children—are intoxicated.

The editor of a California paper says: "Wine-making in Eldorado has paved the way for drunkenness and poverty," and another says: "Wine has become as cheap as milk, and as freely drunk, till many, once sober men, are growing habitually intoxicated. One leading man enumerated to us five of his acquaintances who, once noble men, are now drunkards through wine."

Wines are the fashionable drinks of society. Men who can afford to have wine-cellars with very costly wines, think nothing of drinking several hundred dollars worth with their friends at a single dinner. Each tries to offer the other something more costly. The person to whom it is offered feels that it would be an insult to refuse. Many times a boy, or young man, who has never taken any form of alcoholic drink, takes his first glass because he does not wish to seem rude. But during the last twenty-five years a careful study of the laws of health and a better appreciation of the deadly effects of all alcoholic drinks have led many people to give up the use of wine in entertaining. Some of the wives of the Presidents have never had it on the table of the White House, for they have wished to show to the nation how evil it is in its effect on health and morals.

Malt Liquors.—Malt liquors include all kinds of beer, ale, porter, and stout. They contain from four to eight, and sometimes ten, per cent. of alcohol.

They are made from grains; beer is usually made from barley. Barley contains a great deal of starch, which is partly changed into sugar as soon as the grain begins to grow. Accordingly it is sprouted by moisture and heat, and then as soon as the little barley-plants begin to push out of their seed-coats, they are killed by being put in a hot oven. The grain is then called malt. It is crushed and mixed with hot water, which dissolves all the sugar out of the malted grain. Hops, which give the bitter taste to beer, are added, and then yeast, to make the liquid ferment. It is not bottled as in root beer, and when the carbonic acid gas rises to the top, the frothy scum is skimmed off, but the alcohol remains in.

To make beer is a slow process, and one that takes great care, and if good barley is used it is expensive, and the saloon-keepers do not make a large profit on it; therefore they buy a poor beer that is made of cheap rye or corn, and quassia,

or other bitters, to give it the bitter taste instead of hops. This often has a dangerous chemical, salicylic acid, added to it to keep it, so that in addition to containing the poison of alcohol, it has poisonous adulterations.

People often say that beer is nourishing because it is made of good, wholesome grain, but we have seen that the nourishing part has been changed into alcohol. They also say that it is fattening; so it is, but it makes unhealthful fat, which amounts to disease in such organs as the liver and the heart. It deposits an excess of fat all over the body, and gives a person a coarse, bloated, or, as is sometimes said, a "beery" appearance.

A glass or two of beer may not produce total intoxication as the same amount of whiskey would, but it will destroy the finer senses and judgment and make a man quarrelsome and vicious. It has a peculiarly debasing effect upon the human mind. Dr. G. Bunge, Professor in Basle University, Switzerland, says on this subject: "Nothing gives us so full a glance into the selfishness of mankind as a careful consideration of their relation to the liquor question. What shall we say of a man who thinks to himself: 'Let millions every year of my fellow-men languish in hospitals and asylums; let millions plunge themselves and their families in ruin, or be driven to despair or suicide, so long as I get my glass of beer every morning.'"

Root Beer is a sweet liquid that is made to ferment by the addition of yeast. To sweetened water and a decoction of spicy herbs yeast is added, and the bottles, tightly corked, are set in a warm place. Soon the yeast begins to break up the sugar into alcohol and carbonic acid. Neither can escape until the bottles are opened, when the gas rushes out in bubbles to make the foam, and the alcohol gives the sharp taste to the drink. Thus root beer, even though made at home, is an alcoholic drink, and the use of it may lead to the desire for something stronger.

Such drinks as soda water, sarsaparilla, ginger-ale, or vichy, with lime-juice or lemon-juice, are cooling and do not lead to a craving for more, for they contain no alcohol. They are made to effervesce, by having artificially made carbonic acid gas put into the bottles under pressure. When this escapes it makes a pleasant effervescence.

Distilled Spirits.—Liquors. These are the most intoxicating and the most dangerous of all alcoholic drinks. They are about half alcohol and half water, and are flavored with spices or aromatics. Those in common use are whiskey, rum, brandy, and gin. The taste of each depends on what it is made of and what it is flavored with.

Whiskey is made from corn or rye, and when a cheap quality is wanted, from potatoes. Rum is distilled from fermented molasses, brandy from wine already made from the juice of grapes, and gin from rye and other grains, flavored with juniper berries.

Distillation is the process by which a liquid is turned into vapor by heat, and then condensed and turned into a liquid again. When water reaches its boiling point, at 212° F., it turns into steam. This steam, if caught on a cold plate, turns back to water again in form of dew. Alcohol boils and becomes vapor at a lower temperature than water. Therefore it passes off, leaving most of the water behind, but not all, for alcohol has such a strong affinity for water that it carries some with its vapor.

When brandy is to be distilled from wine, or whiskey from the fermented preparation of rye, the liquid is put in a copper vessel and heated, and the vapor, which is alcohol with some water, is carried off through a long pipe from the top of the still to a coil of pipe that is called the worm, and which is kept constantly cold. Here the vapor is condensed back again into alcohol, mixed with some water. If there is more water present than the manufacturer wants, he distills it again.

As most malted drinks and wines contain only ten to fif-

teen per cent. of alcohol, it takes a large quantity of them to make whiskey or brandy. Therefore, these drinks are as much more expensive as they are intoxicating. Pure alcohol of commerce is obtained by distilling whiskey.

It was a common thing in the early days of this century for every farmer to have a still of his own, and, by distilling cider, to make a liquor called apple-jack that was very intoxicating. At the present day the Government has forbidden the use of all private stills that are not licensed; but, nevertheless, in the wild mountain regions, the farmers have secret stills, and use their scanty crops to make a raw and fiery sort of whiskey that is very intoxicating, and which keeps the whole community in idleness and poverty.

Few people could drink distilled liquors, which scald the throat and burn the stomach, unless their tastes were prepared for them by the use of milder alcoholic drinks. But everyone who has passed through the various stages of drinking, from the use of cider and beer up to the continued use of brandy or whiskey, finds that he constantly wants his drinks stronger, and that every drink increases the desire for more.

Thus it will be seen that alcoholic beverages contain different amounts of alcohol. The larger the percentage of alcohol they contain, the more intoxicating they are, but drinks containing a small percentage of alcohol are quite capable of forming the alcoholic appetite. They are perhaps even more dangerous, for if a boy took a very strong drink of whiskey he would be terribly ill with nausea and headache, and all the horrors of intoxication. This would frighten him, for no boy would ever deliberately start out to be a drunkard; but the pleasant taste of cider, and the fact that he feels only a sense of warmth and exhilaration after it, makes him think there is no harm in it; but the appetite once aroused wants drink with larger and larger quantities of alcohol, so he passes from cider to beer, from beer to wines, and from wines to whiskey,

and from the state of being a pleasant companion to being a disgusting one, until he is a "hard drinker."

In addition to these widely used drinks which are known to contain alcohol there are a great many widely advertised "Tonics," "Bitters," "Elixirs," and a great number of patent medicines, which contain large amounts of alcohol. These are capable of doing a great deal of harm, and are, moreover, deceptive, often establishing a craving for alcoholic drinks in persons who are innocent and ignorant of what they are taking.

Cordials.—These are clear, sweetened liquids, variously colored, containing about one-third alcohol, and flavored with different aromatic and pungent oils, such as peppermint, anise, fennel, orange, etc. They are known by fancy French names, which refer to the flavor or to the place where they were supposed to be first manufactured. Some of them are distilled liquors, to which considerable sugar has been added. Most of them are made artificially by mixing one part of alcohol with two of water, and then coloring and flavoring to suit.

A great many wines, liquors, and cordials are made artificially. Alcohol and water are mixed in various proportions, more or less sugar added, then the peculiar flavor adapted to each variety, and finally a sufficient amount of coloring matter. Many of the substances added in the artificial manufacture of alcoholic drinks are of a very injurious and poisonous character; thus other poisons are added to the alcohol.

Some of the General Effects of the Alcoholic Drinks.—The alcohol in alcoholic drinks does not take the place of a true food, for it is incapable of producing new tissues and cannot make the body stronger, nor give it heat; but, on the contrary, it breaks down the tissues and makes a person less capable of standing hardship or exposure, and lowers the temperature of the body.

Effect of Alcohol on Food.—When a person drinks alcoholic liquors with his meals, the alcohol affects the food

that is taken into the stomach. When a piece of meat is put in alcohol it becomes quite hard, and when a quantity of alcoholic drink is taken with one's dinner, the tender, well-cooked meat is hardened, and the gastric juice has difficulty in digesting it. If you melt a little cheese and pour beer on it, you will see how, from being soft and brittle, the cheese at once becomes tough and stringy. A glass of beer, with a lunch consisting of bread and cheese, would not seem to aid its digestion.

When food tastes savory and appetizing, we eat more of it, but alcohol affects the taste, and makes food seem flat and insipid, unless it is very highly seasoned ; soon a drinking man loses appetite for simple, nourishing food, and it is very common to hear a man say that he never takes any lunch, but a glass of beer.

Alcoholic drinks, by preventing the food in the stomach from being quickly and thoroughly digested, causes fermentation, and this produces a nausea and headache. (They are a common cause of dyspepsia.) So alcoholic drinks are not only useless in themselves, but they diminish the value of nourishing food that may be taken with them.

A Summary of the Diseases Caused or Aggravated by the Use of Alcoholic Drinks.—It is said that every person carries from childhood the cause of his death, such as a weak heart, that will give out in diphtheria or pneumonia ; weak lungs, that will contract consumption, or a weak stomach, that will contract dyspepsia. These are called constitutional weaknesses, and there are none of them that are not aggravated by alcohol.

Alcoholic consumption, physicians say, is the most hopeless kind.

Alcoholic dyspepsia cannot be cured until long after the patient stops drinking.

Pneumonia in people of drinking habits is nearly always fatal.

Heart disease is aggravated by the use of liquors, and some fatal forms are caused by it.

Liver complaints of any kind are aggravated by the use of alcohol, and some forms are due directly to it and to nothing else.

Bright's disease (a disease of the kidneys) is caused in about one-half the cases by the use of alcoholic drinks.

Broken bones in drunkards do not readily unite, and cuts and wounds which would heal quickly in temperate people, are apt to become gangrenous in the unhealthy flesh of intemperate men, and cause their death.

Extreme nervousness is one penalty that every drinking man pays. His hands tremble, his heart palpitates, and he cannot control his finer movements with precision.

Alcoholic Drinks and the Expectancy of Life.— Life insurance companies give us the best estimate of the chances of long life among the victims of the alcohol habit, as compared with those who have abstained from alcoholic drinks. It may be well to explain the principle upon which these life insurance companies do business. Life insurance has for its object the payment of a certain sum of money by the company to the heirs of the insured person, after the death of the latter. In order to become insured, a person is examined by the company's doctor, and must be in good health ; he must then pay a certain sum of money to the company every year, usually only a small fraction of the amount he becomes insured for.

Insurance companies have made out tables showing how long a person can expect to live at any given age ; of course, these show only averages, for none of us can say he will be alive to-morrow, or knows when he will die. These tables give what is called the "expectancy of life" ; they show that the average length of life of persons who indulge freely in alcoholic drink is much shorter than in others, and in the case of drunkards it is very short indeed.

At the age of twenty, the expectancy of life in the sober is forty-four years; in the drunken it is fifteen years. At the age of thirty, the expectancy of life in the sober is thirty-six years; in the drunken it is fourteen years. At the age of forty the expectancy of life in the sober is twenty-nine years; in the drunken it is only eleven years.

Fifty years' experience of one large insurance company has shown that the deaths among men who are engaged in the liquor business and who drink a great deal, are half as many again as among all other classes of individuals at the same age. No company will knowingly insure a drunkard, for the reason that his chances of a long life are very few. Many companies refuse to insure saloon-keepers, because they are usually compelled to take much alcoholic liquor.

Moral Effects of Alcoholic Drinks.—The moral view of the alcoholic question is a very important one. No one will deny that it is a shocking sight to behold an intoxicated man stagger along the street, holding on to anything for support, unable to control speech or motion, offensive in breath, and dirty in appearance.

Money Spent in Alcoholic Drinks.—Even the milder forms of alcoholic poisoning are associated with conditions which are well worth considering. There are millions of dollars uselessly spent for alcoholic drink each year. How many useful things this immense sum of money would purchase, and how much good it might accomplish! Consider how much time is wasted in saloons, often in wretched companionship, which might otherwise be given to the family at home. In 1893, the consumption of alcoholic drink in the United States reached the following enormous figures: Distilled spirits (liquors), one hundred million gallons; wines, thirty million gallons; malt liquors, twelve hundred million gallons. The yearly cost of alcoholic drinks in the United States is said to be over one billion dollars.

Alcoholic Drinks and Crime.—The use of intoxicat-

ing liquor is the most common cause of crime; this fact must be conceded by everyone. One of the reports of the Prison Association of New York contains the following passage: "There can be no doubt that of all the proximate sources of crime, the use of intoxicating liquors is the most prolific and the most deadly. Of other causes it may be said that they slay their thousands; of this it may be acknowledged that it slays its tens of thousands." The Committee asked for the opinion of the jail officers in nearly every county in the State as to the proportion of commitments due either directly or indirectly to strong drink. And what was the answer? "That alcoholic drinks were responsible for at least seven-eighths of the cases of crime."

SYNOPSIS.

The origin of alcoholic drinks.
Alcohol and the alcoholic appetite.
Fermentation. What it is and how to prevent it.
Cider.
Wines.
Champagnes.
Malt liquors.
Distilled spirits, whiskey, brandy, etc.
Bitters, cordials.
Some of the general effects of alcoholic drinks.
Effects of alcohol on food:
    On the food itself; meat, cheese, etc.
    On the stomach and intestines.
A summary of the diseases caused or aggravated by the use of alcoholic drinks.
Alcoholic drinks and life insurance.
The moral effects of alcoholic drinks.
Money spent in alcoholic drinks.
Alcoholic drinks and crime.

QUESTIONS.

1. What class of drinks besides tea and coffee are in common use? 2. Why is it necessary to understand their nature? 3. By what process are they produced? 4. Describe fermentation and illustrate. What change does it produce in the sugar of fruit-juice? 5. What is the nature of alcohol? 6. Describe the craving produced by alcohol. How does it differ from normal appetite? 7. How can the fermentation of fruit-juices be prevented? 8. Describe the results of fermentation in bread-making. 9. What is cider, and how is it made? 10. Give some of the results of cider-drinking. 11. How are wines made, and what danger attends their use? 12. What are malt liquors? How are they made? What is a peculiar effect of beer-drinking? 13. What is meant by distilled spirits? How are they obtained? 14. How is the taste for strong liquors acquired? 15. What are cordials? 16. Why are they to be avoided? 17. What general effects have alcoholic drinks on food taken into the stomach? 18. What are some of the diseases caused or aggravated by the use of alcoholic drinks? 19. What effect has the use of alcoholic drinks on one's probable length of life? 20. What are the effects of alcoholic drinking on the crime of a large city?

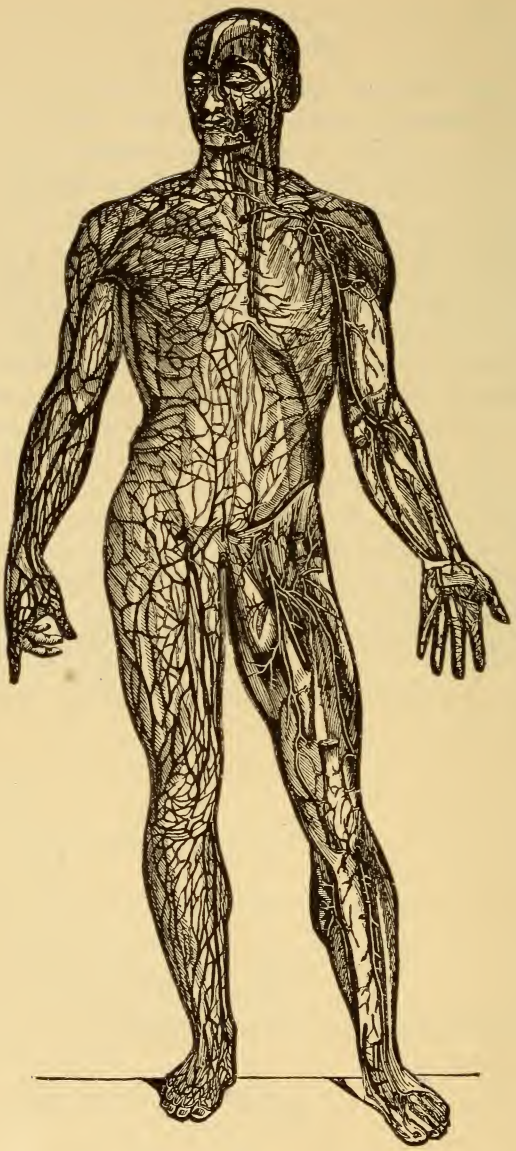


FIG. 49.—The Blood-vessels. In the right half of the figure the arteries are shown; in the left half, the veins.

CHAPTER VIII.

THE BLOOD AND THE CIRCULATION — THE HEART AND THE BLOOD-VESSELS.

If you cut your finger you notice a red fluid escaping from the wound which you call *blood*. If the cut be a slight one, only a little blood will be lost, and the accident will not worry you much; but if it be deeper, you may have trouble in stopping the bleeding, and you would feel alarmed, for everyone knows how important the blood is. It is called *life's fluid*, and it deserves the name; for if one-quarter of the blood is lost, life would be in danger; and if one-third were lost, certain death would result.

Appearance of Blood.—Blood is a thin fluid of a red color. If we look at the blood of an *artery*, the color is *bright red;* but in the *veins* the blood is of a *dark red* color. Why this difference exists will be explained later. Although it has this red color, the fluid part of the blood is not red, but yellowish. It looks red because there are a great many small red bodies floating in it. These we call the *blood-globules*.

Composition of the Blood.—The blood is composed of a *yellowish fluid*, called *plasma*, in which we find millions of small bodies, mostly of a red color, which we call the *blood-globules*.

Blood-globules.—If we take a drop of blood and look at it under the microscope, we can easily see these blood-globules. Even in a small drop of blood, there are about ten millions of them, which will give an idea of the great number there must be in the entire body.

The Microscope.—This instrument has often been alluded to in these pages, and is constantly used in studying the finer structure of different parts of the body. Probably everyone knows what a magnifying-glass is, and has seen it used for making objects look larger. Perhaps, too, many of you have brought the rays of the sun together into a small spot on your hand and found how this burns. On this account, the magnifying-glass is often called a burning-glass. Such a magnifying-glass makes objects appear five or six times as large as they really are. If several very strong magnifying-glasses were placed one over another in a metal tube (Fig. 50), objects looked at through all of them would appear a hundred, or even a thousand times larger than they really were, and this would constitute a microscope.

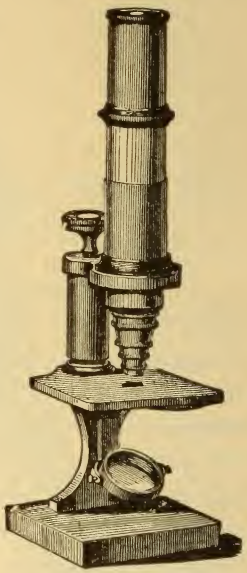


Fig. 50.—The Microscope.

Red Blood-globules.—If a drop of blood be looked at under the microscope, the yellow fluid is seen plainly, and in it we also see the blood-globules in great numbers. Most of these globules are of a *reddish color*, *flat*, with the edge a little thicker than the centre. These are called the *red blood-globules*. After the blood leaves the body, these red blood-globules are apt to stick together at their sides (Fig. 51), and in this way columns are formed looking like rolls of coin piled one upon another.

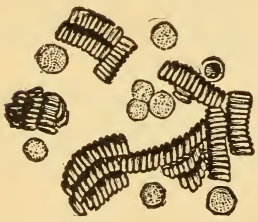


Fig. 51.—Human Red and White Blood-globules. The red globules are seen to be flattened and in rolls; the white ones are alone, dotted, and larger.

White Blood-globules.—Besides the red blood-globules there are others which are white, and somewhat larger than the red (Fig. 51). These are not flat,

but perfectly round, like a sphere, and have two or three spots in their centre. There are very few of these white bodies, which we call *white blood-globules*, compared to the large number of the red ones. We call both the red and the white ones globules, because of their shape, the word globule meaning a little sphere.

The Plasma.—The watery, fluid portion of the blood in which the red and the white blood-globules float is called the *blood-plasma*.

Blood of Other Animals.—In other animals, as in man, the blood is red and is formed of plasma, red blood-globules, and white blood-globules. There is, however, one difference in some animals. In man the red blood-globules are flattened, circular, and perfectly clear, having no spots in the centre.

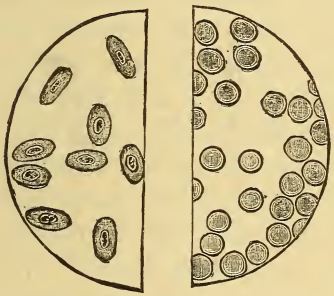


FIG. 52.—The Red Blood-globules in Birds, Fishes, and Reptiles (on left of figure) as Compared with Those of Man (right half of figure).

In many of the larger animals, and in all of our domestic animals, the red blood-globules have this same shape. But in the blood of *birds, fishes,* and certain other animals like snakes and alligators, which we call *reptiles*, the red blood-globules, while still of the same color as in man, are oval in shape, and have a spot in the centre (Fig. 52).

Use of the Red Blood-globules.—The red blood-globules have a very important use, to explain which it will be necessary to say something about the air we breathe. The air is made up principally of two gases: One-fifth is a rich gas called *oxygen*. It is the gas which is necessary for life. The rest is a gas called *nitrogen*, which serves to dilute the oxygen so that it may not be too rich, but just right for breathing. When we inhale air it passes into our lungs and stays there a short time, and while there the blood takes some of the oxygen

from the air. In the lungs there are a great many small blood-vessels. The oxygen passes through the thin walls of these and the blood flowing along takes it up. The watery part of the blood cannot take up the oxygen; the red blood-globules do this. At the same time the color of the blood, which was dark red before the oxygen was taken up, changes to a bright red. After the red blood-globules have taken up this valuable gas, they carry it to different parts of the body and give it to the tissues which have become used up, so that they become built up again.

Use of the Plasma.—The fluid part of the blood also has a special use. When the different tissues of the body are being used up, they give off a poisonous gas which is called *carbonic acid gas.* This gas is quite heavy and often collects at the bottom of wells or in cellars that have been dark and shut up for a long time. You sometimes read of people losing their lives by going down into such wells and cellars, for this gas is so poisonous that the people cannot breathe it and they choke to death. In such cases, if it is suspected that this gas may be collected there, a lighted candle should first be lowered into them; if it will not burn, it would be dangerous there for a human being. For where this carbonic acid gas is present, the oxygen is absent or very little is present, and the candle requires oxygen to burn just as we do to breathe and live. After the plasma has taken up this poisonous carbonic acid gas, it carries it to the lungs where it passes through the walls of the blood-vessels and escapes into the air. This is the reason why the air which we breathe out is not so pure as that which we breathe in.

Difference between the Blood in Arteries and the Blood in Veins.—The blood flowing in the arteries is of a bright red color, because it has just received a supply of oxygen from the air in the lungs, and has given up its poisonous gas to the air. The blood in the veins is of a dark red color because the tissues have robbed it of the oxygen which it had

before, and have given it a large supply of the poisonous carbonic acid gas. The blood in veins is warmer than that of arteries.

Clotting of the Blood.—While the blood is in the body and in the vessels through which it usually moves, it is fluid. But if taken from the body, and placed in the air, it very soon becomes thicker and thicker, and finally is a soft solid, about as thick as jelly. If in a cup, it may then be turned out, and, like jelly, it will retain the shape of the cup. In addition to the thick part, a quantity of yellow fluid will also be found to have separated. Blood never becomes hard, even when it solidifies; it becomes a soft jelly-like solid. This change of the blood from the fluid to the solid state after it is removed from the blood-vessels is called *clotting*. The thickened blood we call a *clot*, while the yellow fluid which separates is called the *serum*. It is, of course, not natural for blood to clot except when it is exposed to the air, or when there has been some change in the blood-vessel. It is quite difficult to understand why this thickening occurs, but if we examine the blood under the microscope after it has clotted we see that a large number of very fine hair-like bodies called fibres have appeared, and that these run in every direction and across one another, and that the blood-globules have been caught and entangled among them; and this makes the blood thicken.

Value of the Clotting of Blood.—This thickening or clotting of blood is of the greatest importance. If it were not for this we should bleed to death every time we cut ourselves. For when a wound is made, the blood flows until a crust forms, and this crust stops the bleeding. This crust is the same thickening, or clotting, of which we have been speaking, and there would be no way to stop bleeding permanently if it were not for this. You might press your finger on the wound and stop the bleeding in this way, but as soon as you took your finger off the blood would flow again.

The Circulation.—Thus far we have been speaking of the blood itself. Now we will study how the blood flows through the body, for our *blood is constantly moving.* This we can see very well in the frog. If we take some part of the frog, as for instance, one of the thin parts of the foot, and spread it out and look at it under the microscope, we shall see the blood in motion. The only reason we cannot see it in man is that there is no part thin enough and transparent enough for us to see through. If we examine the thin part of the frog's foot in this way we shall see a number of tubes,

FIG. 53.—The Blood in Motion, as Seen in the Small Blood-vessels of the Frog's Foot.

and in the centre a fluid full of small bodies—some red, some white—these are the blood-globules. It will be seen that there are a great many red ones and only a few white ones. And you can also notice that the red ones hurry along, a great many in company, in the centre of the stream, while the few white ones seem to rub against the wall of the blood-vessel, and go along quite slowly. It is a beautiful sight and is another illustration of how wonderfully we are constructed. In

studying the manner in which blood flows through our bodies it will be necessary to commence with a description of the heart, the arteries, the veins, and the capillaries.

THE HEART.

Situation of the Heart.—The heart is the most important organ in the body. It is placed in the chest, be-

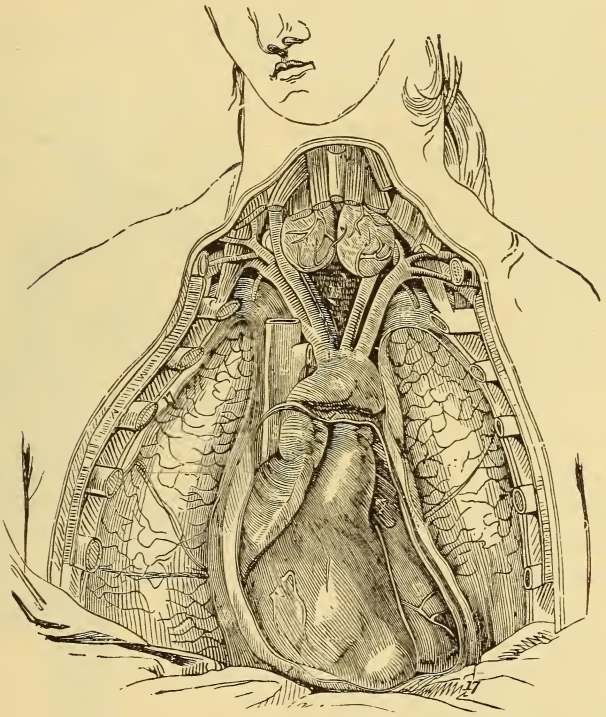


FIG. 54.—The Heart in Its Natural Position. It is surrounded by its sac, the pericardium; on each side the lungs are seen; above, the large vessels are seen springing from it. In order to see all this the front of the chest is represented as having been removed.

tween the lungs, and is covered in front by the breast-bone (Fig. 54). It projects beyond the breast-bone on each side, but

more to the left than to the right. If the hand be placed upon the front of the chest on the left side the beat of the heart can be felt. This corresponds to the position of the pointed end of the heart. If the ear be placed over this spot the sound made by the beating of the heart can be heard.

Form of the Heart.—The heart is shaped like a *cone*, with the wide part above and the point below. It measures five inches from one end to the other. It is *hollow* (Figs. 56 and 57), and its walls are formed of muscle-tissue.

The Pericardium.—The heart is surrounded by a sac, called the *pericardium*, meaning *around the heart*. Between this sac and the heart is a space in which a little fluid is found.

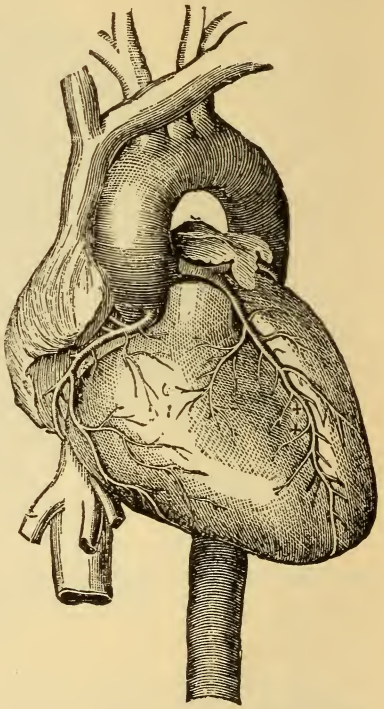


FIG. 55.—The Heart and the Large Vessels Given off from it.

Cavities of the Heart.—The heart is hollow, so as to have spaces through which the blood can flow. It has four such spaces. If we look at the heart from the outside, we can first divide it into two halves, a *left* and a *right*. The right and the left sides of the heart are separated by a groove which runs from the wide part of the heart above to the point below. Then there is a horizontal groove, which runs across this vertical one and divides each side into two smaller parts, an *upper* and a *lower*. If we examine the interior of the heart we find four spaces. The partitions which separate these spaces are placed within, exactly where

the grooves are found on the outside. So that each side of the heart has two spaces, an upper and a lower (Figs. 56 and 57). The upper spaces are called *auricles*, and the lower *ventricles*. Consequently, there is a *right auricle* and a *left auricle*, and a *right ventricle* and a *left ventricle*. The ventricles are much larger than the auricles. The wall of the heart is much thicker on the left side than it is on the right.

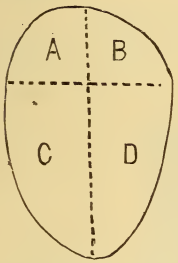


FIG. 56.—Outline Sketch Showing the Arrangement of the Cavities of the Heart. A, Right Auricle; B, Left Auricle; C, Right Ventricle; D, Left Ventricle.

Function of the Heart.—The heart serves to pump the blood into the blood-vessels with such force that it flows all through the body. The walls of the heart are made of muscle, and this muscle is constantly contracting, and each time it contracts we say it *beats*. When it does this the whole heart becomes smaller, and its cavities become smaller, and thus the blood is forced out. After this the heart expands again, its auricles and ventricles become wider, and the blood flows into them from the veins until the heart becomes filled. These actions of the heart are being continually repeated.

Frequency of the Heart-beats.—In the grown person, the heart beats about seventy times a minute. In the child, it beats eighty or more. In the old person it may only beat sixty a minute. When sick with fever, the heart works more rapidly than in health, and then often beats over a hundred a minute.

Course of the Blood.—When the blood leaves the heart it passes from the right side of the heart to the lungs, thence it returns to the left side of the heart, thence it passes into the arteries all through the body, and thence it returns through the veins to the right side of the heart (Fig. 58). The way in which the blood circulates and its course were discovered in 1618, by an Englishman, named Harvey. It was a wonderful discovery. Before Harvey's time nothing was known

about the way in which the blood flows. The ancients imagined that the arteries contain air.

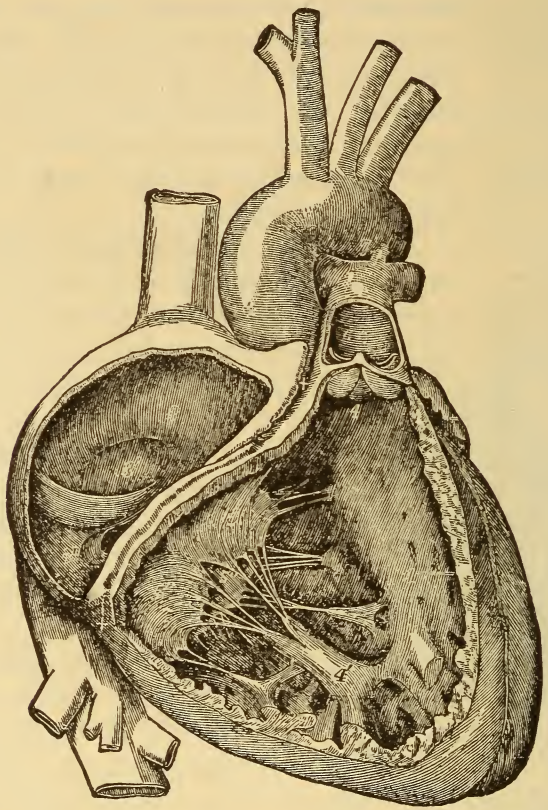


FIG. 57.—The Heart (the Front has Been Removed), Showing the Interior.

The Circulation through the Lungs.—All the blood passes from the veins into the right side of the heart, first into the upper space (auricle), and thence into the lower space (ventricle). When these two become full of blood the heart contracts and squeezes out the blood into a large artery (the *pulmonary* artery), which carries it to the lungs. Here the blood passes into smaller and smaller arteries, and, finally,

into the very finest tubes, which we call the *capillaries* (from a Latin word meaning a hair, because they are so very small).

While the blood flows through these capillaries of the lung, it meets the air taken in when we inhale: and from this

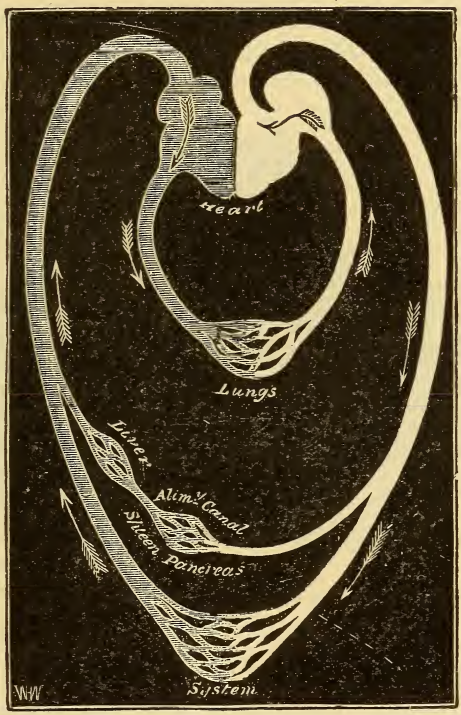


FIG. 58.—Diagram Showing the Course of the Blood Through the Heart, Lungs, and Body in General.

air it absorbs the oxygen, and gives to it the poisonous carbonic acid gas. Thus in passing through the lungs the blood has *gained oxygen* and *lost the poisonous gas;* and in doing this it changes from the dark red color it had before to a bright red color; it is now *purified.* The capillaries soon join to form

larger and larger tubes, and these unite to form several large blood-vessels, which carry the purified blood back to the heart. But this time it passes to the *left* side of the heart, first through the left auricle and then through the left ventricle. When enough blood has flowed into the heart, it contracts and squeezes it out into a very large blood-vessel (the *aorta*), which carries it to the tissues in the different parts of the body.

All this is shown very well in diagram in Fig. 58.

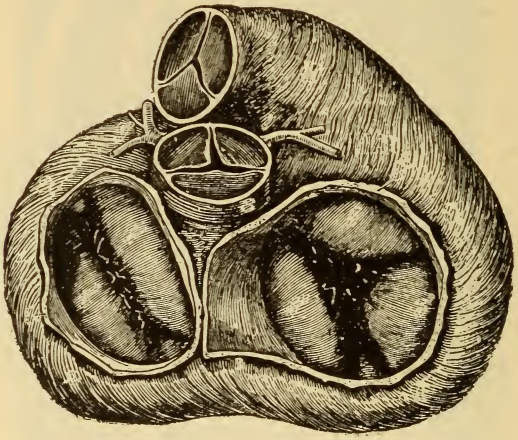


FIG. 59.—The Valves of the Heart, and Between the Heart and the Large Vessels which Leave It.

Starting above, we see the heart; the shaded part to the left representing the right side. The impure blood passes hence to the lungs, gradually becoming purified and brighter as it passes through this organ. From the lungs it is seen to pass in its bright color to the left side of the heart (which is the portion of the heart unshaded on the diagram). Hence it passes along, as the arrow indicates, to the different parts of the body, called on the diagram the *system*. Passing through the system and through the abdominal organs,

as shown in the diagram, the blood gradually becomes darker, and is shown to be carried by the large veins back again into the right side of the heart, the point at which we began to trace it.

Valves of the Heart.—The valves of the heart resemble lids which are placed between the different spaces in the heart. They allow the blood to flow one way, but when it attempts to return in the opposite direction, they close up and prevent it. Fig. 59 shows them closed, thus shutting off and separating the different cavities of the heart. There are also similar valves placed between the heart and the large vessels which leave it. It will readily be seen how important it is that such a valve should exist between the left ventricle and the large artery which distributes the blood to the different parts of the body, the *aorta;* this valve prevents the blood from flowing back into the heart after it has been forced into the aorta.

THE BLOOD-VESSELS.

Those blood-vessels which take the *purified blood* from the heart and distribute it to all parts of the body are called *arteries.* The blood-vessels which return the *used-up* blood from the tissues to the heart are called *veins.* Between the smallest arteries and the smallest veins are the very finest blood-vessels, which are called *capillaries.* So that the blood, after being purified, passes through arteries, then capillaries, then veins.

The Arteries.—The large artery which leaves the left side of the heart, the *aorta,* soon divides and subdivides, and these branches pass in many different directions, constantly giving off other and smaller branches. A tree forms a very good example of how the arteries run in the body ; the large trunk of the tree corresponds to the large artery which leaves the heart, and the branches correspond to the branches of these arteries.

The Pulse.—When you are sick, and the doctor is called, one of the first things he does is to feel your pulse. He will put his finger upon your wrist and he will take out his watch. Why does he do this? He is counting your *pulse.* If you put your finger upon your own wrist, in front, on the side on which the thumb is, you will feel something beating. This is an artery, and the beating you feel is your pulse. Every time the heart beats the arteries beat, and this gives what is called the pulse. This will be understood if it be remembered that every time the heart contracts it pumps blood into the arteries, and every time another heartful of blood is forced into the arteries, being elastic, they expand and grow wider. It is this expansion which is felt with your finger, and which is called the pulse. When the doctor counts the pulse, he can tell how slowly or how rapidly the heart is beating; for the pulse is the same in number as the heart-beats. The reason we usually take the pulse at the wrist is because it is most convenient; but there is a pulse in every artery of any size in the whole body. You can feel one at your temples, one at the side of your neck, and in many other places.

The Capillaries.—These are the very smallest blood-vessels, and they connect the arteries with the veins. We find the capillaries almost everywhere. They are so small that we cannot see them without the use of the microscope. If you scratch yourself and a little blood comes, this is from some of the capillaries, not from an artery or vein; for if an artery or vein is injured it is more serious. It is while the blood is passing through the capillaries from the arteries to the veins, that the tissues take from it the oxygen and give up to it the poisonous carbonic acid gas. And after this change has taken place, the color of the blood has changed from the bright red of the purified blood in the arteries to the dark red of the impure blood in the veins.

The Veins.—After the blood has passed through the different tissues by means of the capillaries these unite to form

the smallest veins, and many of these join to form larger ones, until finally we have a single large vein, just as we had a single large artery. But there is this difference: The artery started from the heart and went to the tissues; the veins start in the tissues and gradually join into a large one which goes to the heart. The arteries, too, contained bright-red, pure blood; the veins are filled with dark-red or purple, impure blood.

Valves of the Veins.—There is still another difference between veins and arteries: Veins have *valves* (Fig. 60). In the arteries the blood has no difficulty in going anywhere, even up-hill, because the heart pumps it along with considerable force. But there is nothing of this sort behind the blood in the veins, for after the blood has travelled through the capillaries it has lost most of the force given it by the heart. It would therefore be impossible for the blood to flow up-hill in the veins, as, for instance, in the legs, if there were not some arrangement for this purpose. This arrangement consists in having valves (Fig. 60) which allow the blood to flow toward the heart, but close up, and thus prevent it from going in the opposite direction.

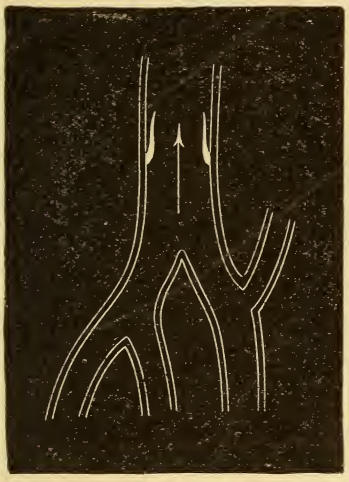


FIG. 60.—A Pair of Valves in One of the Veins. They are open; the direction of the flow of blood is indicated by the arrow.

Rapidity of the Circulation of the Blood.—The blood flows through its vessels very quickly, and it takes about half a minute for it to pass from the heart through the lungs, all through the body and back again to the heart. How many blood-vessels must it pass through in this short time!

Fainting.—When a person becomes pale and would

fall if he did not hold on to something, we say he has *fainted.* This often happens after he has been sick and tries to walk before he is strong enough. The proper thing to do for such a person is to lay him down perfectly flat. There should be no pillow underneath the head. If possible, the head should be even lower than the rest of the body so that the blood may run into the head and fill the blood-vessels of the brain; for the usual reason for the fainting is that the heart becomes weak and

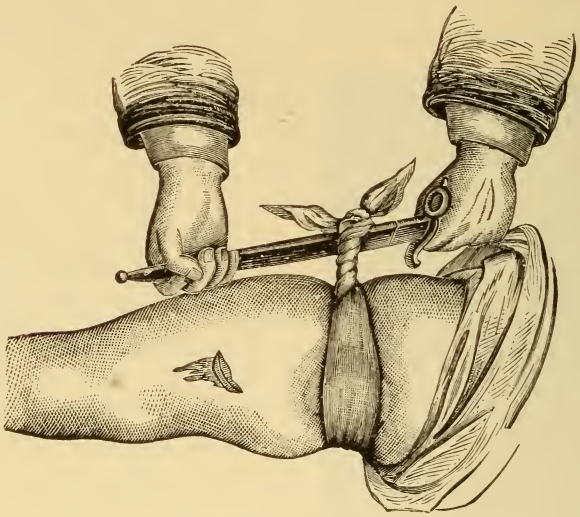


FIG. 61.—Method of Controlling Bleeding from a Large Wound.

has not sufficient force to send enough blood to the brain. It is also important that no crowd should gather around the person, so that he can get all the air possible. The extremities should be stroked or rubbed toward the trunk, so as to facilitate the flow of blood.

Bleeding.—If we hurt ourselves in any way and the bleeding is slight, it will usually stop of itself or after we apply a little court-plaster. But suppose we receive a deep cut and the blood flows freely and we cannot stop it, what shall

we do until the doctor arrives? We should press upon the injured part *just above the cut*, or tie a string around it instead of pressing with the finger. For instance, if it is the tip of the finger which is bleeding very much, we can tie a string around the finger an inch or so above the cut and this will stop the bleeding. If it is a larger part, as the arm or the forearm, tie a handkerchief around the limb *above* the injury and tighten this by means of a stick put under the handkerchief, and twist until it is very tight (Fig. 61). Another name for bleeding is *hemorrhage*.

How to have a Good Circulation.—If we wish to be in good health, the circulation must be good and brisk. If the circulation be sluggish, we are apt to suffer in all parts of the body, because no part gets as much blood as it should. With a poor circulation the feet are apt to be cold in winter, the person catches cold easily, he is quickly *chilled*, he may have headache, and he is not in the best of health. If we want good health, our circulation must be good.

Exercise is the great medicine for a good circulation. Any good form of exercise will answer and exercise in the open air is the best, because while we are making our blood go faster we are also getting more oxygen to the tissues and building them up more quickly. Too much exercise, making one very tired, or too severe exercise, such as lifting too heavy weights, is injurious, because it tires out the heart and makes it weak. And if the exercise be much too severe there is even danger of bursting a small blood-vessel, though this does not happen often.

Effect of Alcohol upon the Blood and Circulation.—The first immediate effect of a drink of liquor is a warm sensation all over the body, especially in the face, which becomes flushed. This is because the alcohol drives the blood to the capillaries under the skin where it soon becomes cooled by the air, so that instead of making the blood warmer it really cools it. The capillaries and walls of the arteries are very

elastic, and when they are filled with blood they stretch to their utmost, and then regain their natural size. But frequent stretching causes them to lose their power to contract and they remain dilated. The only part of the body where this can be seen is in the nose and cheeks, which in a drinking man are covered with a fine network of veins that are red or purple from being gorged with blood. The effect is the same, however, in other organs of the body, and in some cases the frequent dilation causes the walls of the blood-vessels to become so thin that they burst. When this happens in the brain the blood that escapes forms a clot which presses on the delicate cells of the brain and causes death by what is known as apoplexy.

The blood is directly affected by alcohol. If a lot of cherries were placed in alcohol they would become hardened and somewhat shrivelled, because the alcohol would suck all the water out of them. When alcohol is circulating in the blood an effect similar in proportion to the amount of alcohol present happens to the little red corpuscles in the blood. The alcohol absorbs water from them and leaves them shrunken and impaired.

These red blood corpuscles are the scavengers of the blood. They run around through the capillaries carrying oxygen, which burns up here a little clot of worn-out muscle, there a little useless fat. When a number of them are out of order and cannot work the blood becomes filled with impurities that are not oxidized or burned, and these break out in the form of pimples or blotches.

The use of alcohol also tends to make the blood lose its power to clot, so that if a drunkard receives a wound or cut the blood which ought to close the wound naturally and exude the serum that forms new tissue, is too thin to do this readily and the wound is a long time healing. Sometimes it will not heal at all, and a man dies from a hurt that would not have been fatal had his blood not been so poor from the effects of alcohol.

Effects of Alcohol upon the Heart.—When a drink of alcoholic liquor is taken it usually increases for a few minutes the beating of the heart, but lessens its force. It is the nerves of the heart that are affected by alcohol. There are at least two kinds: one that acts on the muscles to force the blood through, and another set that make the muscles hold the blood back, letting it go just fast enough. The first set act like a whip, and a second set like a pair of reins to hold a horse in.

If a man who was driving a spirited horse should suddenly have his hands paralyzed the reins would slip through them, and the horse would run at full speed until he was tired, then he would gradually slacken his pace and walk slowly. This is the effect of alcohol. It paralyzes the nerves that hold in the muscles of the heart, and as soon as their grip is loosened, the nerves that urge the muscles on have it all their own way, and the heart beats at the rate of ninety or more times to the minute, instead of about seventy times. Soon it gets tired and goes more weakly and slowly. While it is racing along a man feels that he can do anything; that is why he says that a drink of whiskey braces him up and puts new life into him, and why, when the exciting influence has worn off, he feels so tired and blue and depressed, and does not want to work.

One form of heart disease caused frequently by the use of alcohol is called "Fatty Degeneration of the Heart." The heart is all muscle, but alcohol causes little portions of the tissue to give place to globules of fat. It becomes enlarged and gradually grows weaker until it stops beating, for there is no medicine that can change the unhealthy fat back into good muscle.

Another form of heart disease is due to the gradual weakening of the walls through the extra pressure put upon them. A man accustomed to the use of alcohol may not know that his heart and blood-vessels are weakened, and suddenly, without

any warning, a little over-exertion may rupture their walls and he will die from the effects of the hemorrhage.

Effects of Tobacco upon the Heart and Circulation.—Tobacco also causes an irregular action of the heart. Sometimes it beats feebly and sometimes very fast and hard. This is called palpitation. It is a distressing trouble, for the heart feels as if it were fluttering like a bird.

By feeling the pulse a physician can detect a "tobacco heart," which means a heart that is suffering from the influence of tobacco. About one of every four tobacco-users has some trouble of this nature with the heart. Very few young boys who smoke cigarettes can be found who have no form of heart disease. Physicians who are authorities on the subject say that cigarette smoking or the use of tobacco in any form should be expressly forbidden to growing boys.

The heart is the organ that is chiefly affected by the use of tobacco, but as it is the vital organ, any trouble with it seriously affects the rest of the body. The circulation and the digestion are apt to be poor and the breath to be offensive. It is rarely that men who drink do not smoke, the two habits go hand in hand, the one injuring the brain and the other the heart; so that when a man with these habits established presents himself to a physician for any treatment whatsoever, his chances are lessened; for every organ in his body is either directly or indirectly affected.

THE LYMPHATICS.

Besides the blood-vessels there are other small tubes, in which there flows a colorless fluid, looking like water, which is called *lymph*, and these tubes are therefore called *lymphatics*. They are shown in Fig. 62. They differ from the blood-vessels in not containing blood; another difference is that all the lymphatics *run toward the heart*.

The lymphatics begin by the very smallest tubes, as small or smaller than the very finest capillaries. They then join together and form larger vessels, and finally they form two

large tubes which open into the large veins in the neck (Fig. 62).

The lymphatics help the veins in returning the used-up fluids of the tissues to the heart. We have already learnt that

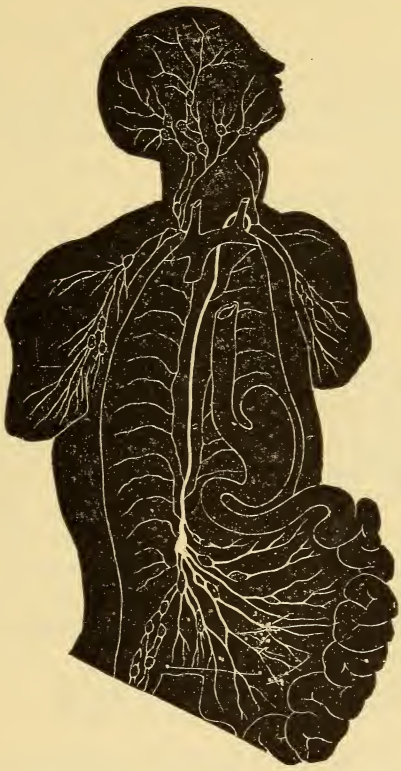


Fig. 62.—The Lymphatics and Lacteals.

fresh, bright blood is brought to the tissues by the arteries, and that it circulates through the capillaries of the tissues. After the tissues have removed the nutritious portions, the used-up fluid is returned to the heart, partly by the veins and partly by the lymphatics.

In studying digestion we found that there are certain

vessels in the abdomen which collect the nutritious juices from the stomach and intestines and convey them to the blood. These are called *lacteals*, and they are merely a part of the lymphatics.

SYNOPSIS.

The Blood:

1. Importance—'Life's fluid;' death when one-third is lost.
2. Appearance—Thin, watery fluid; red color, bright or dark.
3. Composition:
   (1.) Globules:
   a. Red—Flat, edge thicker than centre, circular in man and many animals; oval and spot in centre in birds, reptiles, and fishes; serve to carry the oxygen to the tissues; very numerous.
   b. White—Larger, dotted; much less numerous.
   (2). Plasma—The fluid of the blood serves to carry the poisonous carbonic acid gas from the tissues to the lungs.
4. Difference in Arteries and Veins:
   (1.) In arteries—Bright red; contains more oxygen and less carbonic acid gas; cooler; purer.
   (2.) In veins—Dark red; contains less oxygen and more carbonic acid gas; warmer; more impure.
5. Clotting:
   (1.) Occurrence—When removed from or change in the blood-vessels.
   (2.) Products—Clot and serum.
   (3.) Value—Serves to stop bleeding.

The Heart:

1. Situation—Between the lungs, behind the breast-bone.
2. Form—Cone-shaped, pointed end downward; hollow.
3. Covering—Sac called the pericardium.
4. Structure—Muscle-tissue; a horizontal and a vertical groove divides it into two upper and two lower portions, a left and a right half.
5. Cavities—Four: right auricle, right ventricle, left auricle, left ventricle.
6. Function—To pump the blood into the lungs and all parts of the body through the arteries.

7. Frequency of Beats—In adults, about seventy times per minute; in children, more; in the aged, less; in fevers, more.

8. Valves—To separate the different cavities, when necessary, and to prevent the return of blood pumped into the aorta.

The Circulation—discovered by Harvey in 1618:

1. From right auricle to

2. Right ventricle, then through pulmonary artery to

3. Lungs; here the blood meets the air and is purified, taking up oxygen and losing the poisonous carbonic acid gas. From the lungs it returns to

4. Left auricle, then to

5. Left ventricle; then it is forced into

6. The aorta, and then through the branches of this into

7. The arteries, carrying it to different parts of the body; from these it passes into

8. The capillaries, which join to form

9. Veins, and these gradually grow larger, and finally empty into a very large one which enters the right auricle of the heart.

10. Rapidity—It takes about half a minute for the blood to pass from the heart through the lungs and the system back to the heart again.

The Arteries:

1. Function—To carry pure, bright blood to the tissues.

2. Origin—From the aorta, which springs from the heart.

3. Branches—Constantly become smaller.

4. Pulse—Owing to the contraction of the heart.

5. Direction of Flow—From the heart to the tissues.

The Veins:

1. Function—To carry impure, dark blood from the tissues to the heart.

2. Origin—From the capillaries, smaller ones gradually uniting to form larger ones.

3. Branches—Gradually becoming larger.

4. No pulse.

5. Direction of Flow—from the tissues toward the heart.

6. Valves—To aid the flow of the blood toward the heart.

The Capillaries:

1. Connect arteries and veins.

2. Allow the tissues to abstract oxygen and nutritious matters and to add carbonic acid gas and used-up fluids.

3. Very small, can only be seen by microscope.

Accidents to and Care of Circulation:

1. Fainting—Due to scarcity of blood in brain; lay person horizontal, with head low; plenty of air; rub extremities toward the trunk.

2. Bleeding:

a. If slight will stop by itself, or after use of court-plaster.

b. If severe, press upon the injured part just *above* the cut, or tie something around it here.

3. Good Circulation necessary to good health.

4. Necessity of proper exercise to keep up a good circulation.

5. Effects of Alcohol upon the Heart and Circulation:

a. Enlarges heart.

b. Weakens it.

c. Makes heart fatty.

d. Flushed face.

e. Changes arteries.

f. Apoplexy, bursting of one of arteries of brain.

6. Effects of Tobacco upon the Heart and Circulation:

a. Causes heart to beat too rapidly or too slowly.

b. Causes heart to beat too weakly or too strongly.

c. Causes heart to beat irregularly.

The Lymphatics:

1. Description—Small tubes containing a colorless fluid called "lymph."

2. Differ from blood-vessels in not containing blood, and in that they all run toward the heart.

3. Begin by very smallest tubes, which by joining together form larger ones.

4. End by two large tubes, which empty into the large veins of the neck.

5. Function, to help the veins in returning the used-up fluids of the tissues to the heart, and also to convey nutritious fluids from the intestines to the blood-vessels by means of the

6. Lacteals—A part of the lymphatics.

QUESTIONS.

1. What is meant by the words 'life's fluid?' 2. What happens if the body loses a large amount of blood? 3. What does blood look like? 4. Why does blood look red? 5. What difference is there in the appearance of the blood in arteries and of that in veins? 6. Of what two parts is blood composed? 7. Are the blood-globules very abundant? 8. What is a microscope? 9. What is it used for? 10. What do you see when you look at a drop of blood under the microscope? 11. Are any of the blood-globules white? 12. What is the color of the blood of other animals than man? 13. How do the red blood-globules in birds and fishes differ from those of human blood? 14. What is the use of the red blood-globules? 15. Of what gases is the air made up principally? 16. Which is the more useful gas? 17. What happens to the air when we take it into our lungs? 18. What part of the blood takes oxygen from the air? 19. What do the red blood-globules do with this oxygen? 20. What do the tissues do with it? 21. Of what use is the fluid part of the blood? 22. What is carbonic acid gas? 23. Is it harmless or poisonous? 24. Where is it sometimes found outside of the body? 25. How can we tell that no poisonous gas exists in cellars or at the bottom of old wells? 26. What part of the blood takes up this poisonous gas from the tissues? 27. What does the blood do with this poisonous gas? 28. What becomes of this poisonous gas in the lungs? 29. What is the difference in color, heat, and purity of the blood in veins and of that in arteries? 30. What happens if blood is taken from the blood-vessels and allowed to stand in the air? 31. What is this thickening called? 32. What do we see when we examine clotted blood under the microscope? 33. Of what use is this clotting of the blood? 34. What would happen when we cut ourselves if the blood did not clot? 35. What is the best way of seeing the blood in motion? 36. What do we see when we examine the circulation of the blood through the thin part of the frog's foot? 37. What is the most important organ in the body? 38. What is the shape of the heart? 39. What surrounds the heart? 40. About how long is the heart? 41. Of what kind of tissue are the walls of the heart formed? 42. Where is the heart? 43. Where can you feel the heart beat? 44. If you put your ear over this spot, what do you hear?

45. Is the heart solid or hollow? 46. How many spaces are there in the heart? 47. How is the heart divided? 48. How are the sides of the heart divided? 49. What are the upper spaces called? 50. What are the lower spaces called? 51. Which are the larger? 52. What is the use of the heart? 53. What does the heart do when it beats? 54. How often does the heart of a grown man beat in a minute? 55. How often does the heart of a child beat per minute? 56. How often does the heart of an old man beat per minute? 57. How does the heart beat when we have fever? 58. Describe the course which the blood takes. 59. Where does the blood pass to from the right side of the heart? 60. Where from the lungs? 61. Where from the left side of the heart? 62. Where from the arteries? 63. How is the blood returned to the heart from the different parts of the body? 64. Who discovered the circulation of the blood and when? 65. How does the blood get from the right side of the heart into the lungs? 66. After the large artery carries it to the lung, where does it pass to? 67. What is a capillary? 68. What happens to the blood when it is passing through the capillaries of the lung? 69. How does it change its appearance while passing through the capillaries of the lungs? 70. Where does the blood pass after it has been purified by the lungs? 71. Where does the purified blood pass to after it reaches the heart? 72. What are the valves of the heart? 73. What is their use? 74. What three kinds of blood-vessels are there? 75. What is an artery? 76. What is a vein? 77. What is a capillary? 78. Do arteries branch? 79. What is meant by "the pulse?" 80. How can we feel the pulse? 81. How is the pulse produced? 82. Where do we usually take the pulse, and why? 83. What sets of blood-vessels are connected by the capillaries? 84. What change takes place in the blood while it is passing through the capillaries? 85. What differences are there between the vein and the artery? 86. What have the veins which the arteries do not have? 87. Of what use are these valves? 88. How long does it take the blood to travel through the entire body? 89. What is fainting? 90. What should you do when a person has fainted? 91. Why should the head be low? 92. What should we do for slight bleeding? 93. What should we do for serious bleeding which will not stop? 94. What is apt to result if our circulation is sluggish? 95. What effect has exercise upon the circulation? 96. What effect has too much or too violent exercise? 97. What effect has

alcohol on the heart? 98. What effect has alcohol on the arteries? 99. What is apoplexy? 100. What effect has tobacco upon the heart? 101. What other set of tubes is there in the body besides the arteries? 102. What are the lymphatics? 103. Of what use are the lymphatics? 104. What is that portion of the lymphatics which we find in the abdomen called? 105. Into what do the lymphatics finally empty?

CHAPTER IX.

DIGESTION.

The word *digestion* means the changing of the food by the organs in the abdomen, so as to liquefy it in order that the blood can take it up and make tissues out of it. Digestion commences in the mouth and ends in the large intestine. If we commence from above, the following parts are met with: mouth, throat, gullet, stomach, small intestine, pancreas, liver, large intestine. All of these, except the pancreas and the liver, are hollow organs through which the food passes. All of these hollow organs taken together form the *alimentary canal.* Each of the organs of digestion will now be considered.

THE MOUTH.

This is the commencement of the alimentary canal (Figs. 36 and 67) and is the cavity in which the food is chewed and mixed with saliva.

The Teeth.—The chewing is done by means of the *teeth.* These are supported by the jaws and occur in two rows, an upper and a lower. We do not have the same teeth when we are grown that we had when we were very small; all the the teeth of young children fall out; they are only temporary, and hence are called *temporary* or *milk teeth.* There are ten of these in each jaw, making twenty altogether.

In the sixth year, or before, the temporary teeth begin to fall out, and after the sixth year, others commence to grow

to take their places. These are stronger than those which grow first, and there are more of them. They are called *permanent*

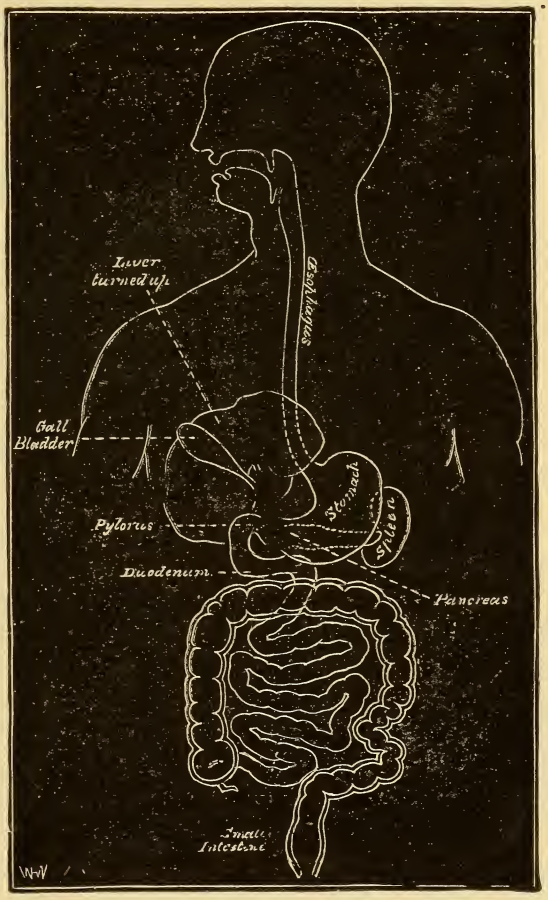


FIG. 36.—Outline Sketch of the Organs of Digestion.

teeth ; and there are sixteen in each jaw. After the sixth year, the other permanent teeth gradually replace the temporary ones,

which fall out. The last tooth to appear is that placed farthest back, called the *wisdom-tooth;* this comes about the twenty-first year.

Each tooth can be divided into the part which projects

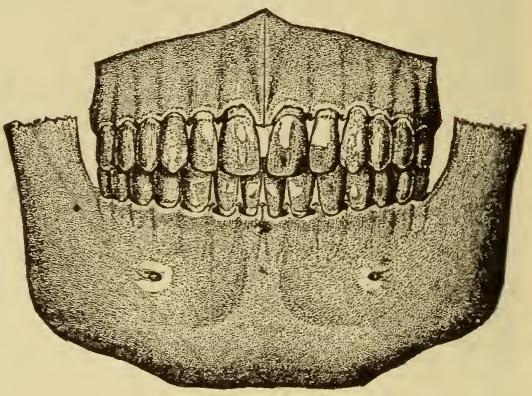


Fig. 37.—The Upper and Lower Jaws with the Permanent Teeth.

into the mouth, above the gums, called the *crown*, the part which sinks into the jaw, the *fang* or *root*, and the line between these two, called the *neck*. Teeth are composed of a very hard material, consisting very largely of lime, called *dentine*. They are hollow in the centre (Fig. 38) and this central space is filled up with a soft material called the *pulp*. On the surface of the crown is a covering of very hard material, formed principally of lime, called *enamel*. Each tooth is supplied with a small nerve which enters it through an opening in the end of the root. It is the exposure of this nerve through the formation of cavities in the teeth which most often gives rise to toothache.

Fig. 38.—Section of One of the Molar Teeth.

Upon examining the teeth, we find they differ greatly in size and shape. They are similar on the two sides of the mouth and are the same in the upper as in the lower jaw. In

Fig. 37 we see the teeth in position; in Fig. 39 they are separated, those on the right of the figure corresponding to the middle line, while those on the left are the back teeth. Commencing in the centre and proceeding toward each side (from right to left in Fig. 39) there are first two sharp-pointed teeth, having chisel-like edges, called the *incisor* teeth. Their sharp edges are intended to *cut the food* and to bite it into pieces. Next to these is a long, pointed tooth, called the

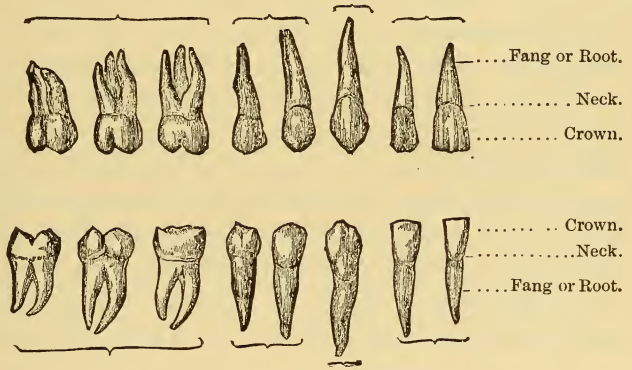


Fig. 39.—The Permanent Teeth. Above are those of the upper jaw; below, those of the lower jaw. The teeth of one side of the jaw only are represented. The two teeth to the right are *incisors*. The long tooth next to these is the *canine* tooth. The following two are *bicuspids*. The last three (to the left) are *molars*.

canine, also known as the *eye-tooth*. In the dog and cat, and animals of this type, this tooth is of great length and sharpness, and is used for *tearing* meat. Next to the canine are two broader teeth having two sharp points each, known as the *bicuspid* teeth. Still further back there are three large, broad teeth, the surface of whose crowns is very uneven, but they are very strong; they are the *molars* and serve to *grind up* the food into small particles.

The teeth are intended to chew the food so that it is in small enough particles to be received and digested by the

stomach. *Hasty eating* results in the swallowing of food which has not been chewed sufficiently, thus causing *indigestion*, *pain* in the stomach, and, if continued, *dyspepsia* (which means difficult digestion).

Care of the Teeth.—Teeth are natural *ornaments* when clean and healthy; but very disfiguring when dirty or decayed. Teeth should be brushed every morning upon rising, and every night before retiring; they should be kept clean at all times. If particles of food lodge between the teeth, they should be removed with toothpicks of wood or quill; never with pins, needles, or metallic points. Teeth are apt to decay and cavities to form, if the general health becomes poor, or if much improper food be taken. By improper food is meant, a great many pickles, much candy and cake, and food which is difficult to digest or too acid. Teeth should not be used to crack nuts with, nor for anything but chewing. When cavities have formed in the teeth, the dentist fills them with gold or silver foil to prevent them from decaying more.

The vulgar habit of chewing tobacco discolors the teeth, makes the breath offensive, and injures digestion.

THE SALIVARY GLANDS.

We give the name *glands* to certain bodies, usually small and round, in which fluid is formed to be used in various ways. For instance, around the mouth there are many such glands, which form the *saliva;* that is, the fluid which constantly keeps the mouth wet, and moistens our food; hence these glands around the mouth are called the *salivary* glands. There are a great many of them, but most of them are very small. Three, however, are large and worth mentioning.

The largest is placed in front of the lower end of the ear around the joint of the lower jaw, and has a small tube leading to the mouth. It is called the *parotid* gland. Another

is placed just below the tongue, and is therefore called the *sublingual* gland. A third is found underneath the chin on each side, and is called the *submaxillary* gland.

These glands pour some of the saliva into the mouth all the time, but they are especially active when we use the jaws either in speaking or in eating. If it were not for this fluid, the mouth would soon feel dry after talking a little. In eating anything dry, as a cracker, we notice that enough fluid forms in the mouth to moisten it thoroughly and thus enable us to swallow the mass. It would be difficult to swallow this if it were dry. When the saliva is mixed well with the food, the stomach can act on the food at once and digest it more easily. This is another reason why we should chew our food well.

There is still another reason. A small part of starchy food is digested by the saliva before it reaches the stomach, thus aiding the stomach in its work of digestion.

Effects of Chewing Gum.—The habit of constantly chewing gum not only looks bad, but by making the saliva flow in large quantity all the time, it makes it thin and watery. Such saliva is apt to be inefficient in the proper performance of its work during meals. This habit is, therefore, not only vulgar, but unhealthy.

THE THROAT.

This is the wide part of the mouth behind, into which the food passes after it has been thoroughly chewed and when we swallow it. While we are swallowing, it passes into the throat. Once swallowed, the food passes into the canal leading to the stomach, the *gullet*, or *œsophagus;* thence it continues its way without our knowledge or will (Fig. 36).

THE TONGUE.

This is also one of the organs of digestion, since by its movement the food is rolled around in the mouth and mixed thoroughly with saliva. The tongue also assists in swallowing. This organ will be described under the special senses, as it is also the organ of taste.

THE GULLET, OR ŒSOPHAGUS.

This is a long tube (Fig. 36) which connects the mouth and throat with the stomach. Its walls are formed of rings of muscle-tissue. When these rings contract, the food is forced downward until it reaches the stomach.

THE STOMACH.

The stomach is a bag about a foot long, placed in the upper part of the abdomen, just below the diaphragm. The latter, as has already been mentioned, is the sheet of muscle-tissue separating the abdomen from the chest. The stomach commences near the middle of the body, and then extends over toward the right. There are *two openings* into the stomach. One is *for the entrance of food*, which is carried by the gullet from the mouth; and in order to reach the stomach, the gullet must, of course, pass through the diaphragm. The other opening of the stomach is at the farther end, and *allows the food to pass on* into the intestines after the stomach has done its work. Around this opening is a narrowing which remains closed until the food is ready to be sent to the intestines. This narrowing is produced by a thickening of the tissue at this point, and is called the *pylorus*.

The wall of the stomach is not very thick, but it is very strong. On the outside there is a smooth, shining coat, which is merely a part of a membrane lining the whole inside of the

abdomen and the organs within it. This membrane is known as the *peritoneum.* On the inside there is a soft, velvety coat,

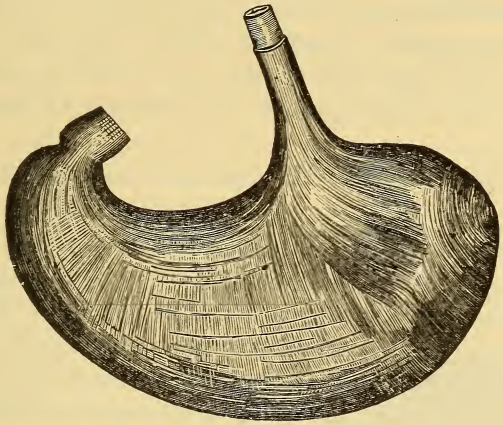


FIG. 40.—The Stomach, Showing the Layer of Muscle-tissue by which it Contracts and Propels the Food.

called the *mucous* layer (Fig. 41). We often meet with the term *mucous membrane* in anatomy. It refers to a soft, smooth,

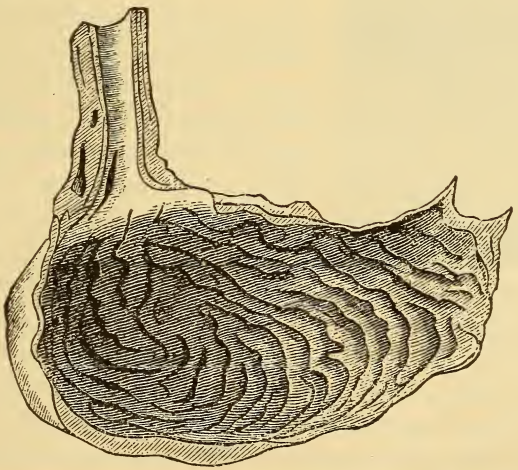


FIG. 41. – The Inner Surface of the Stomach, Showing the Mucous Layer Arranged in Folds.

velvety membrane which is called the mucous membrane because it forms a watery, slippery fluid called *mucus;* the fluid from the mouth between meals, and the fluid which runs from the nose are examples of mucus. Between these two surfaces, the mucous and the peritoneum, is a layer of *muscle-tissue* which forms the main part of the thickness of the stomach (Fig. 40).

Gastric Juice.—The inner, or mucous layer of the stomach is arranged in a series of folds which are especially marked when the stomach is empty. It is usually of a pink or a grayish color, but its color and appearance differ greatly, depending upon whether it contains food or not. When food reaches the stomach, it excites it, and the soft lining then begins to swell, and becomes reddened. This mucous layer, when looked at under the microscope, shows a large number of small dots or openings. When food is in the stomach, we can see drops of fluid escape from these dot-like openings. This fluid is called the *gastric juice.*

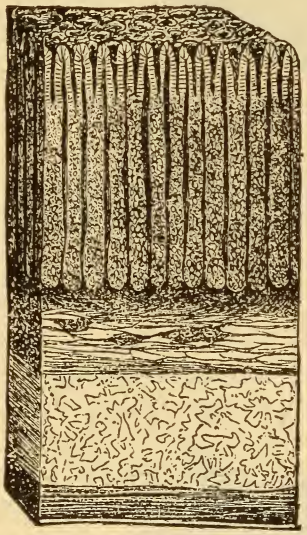


FIG. 42.—A Section of the Lining Membrane of the Stomach Very Highly Magnified, Showing the Gastric Tubules in Position.

The Gastric Tubules and the Gastric Juice.—The gastric juice is a very important fluid; and it is found in the stomach only when food is present, which food causes it to flow. Of course the lining of the stomach is never dry, but it is moistened only with mucus, except when excited by food, when as just stated gastric juice begins to flow. Upon examining this internal layer of the stomach under the microscope, we find thousands of small tubes, lined by little oblong bodies, which we call *cells* (Figs. 42 and 43).

These cells pour the gastric juice into the small tubes, and from these it passes into the stomach and is mixed with the food. But, it may be asked, from what do these cells take the gastric juice? They get it from the blood. There are tiny blood-vessels everywhere, and certain portions of the blood pass through the walls of the blood-vessels into the cells, and are mixed there with other substances; and in this way the gastric juice results.

Fig. 43.—One of the Gastric Tubules. Very Highly Magnified, Showing the Central Canal and the Cells Lining the Tubule.

Pepsin.—The substance in the gastric juice which enables it to digest fleshy food is called *pepsin.*

Function of the Gastric Juice.—The work of the gastric juice is to digest food. But it does not digest every sort of food. It *will digest only fleshy food.* Vegetable food is digested elsewhere—a little by the saliva, but chiefly in the small intestine. Fat, also, remains undigested in the stomach, and passes on to be digested in the small intestine.

(1.) **Uses of the Stomach.**—One of the uses we have just stated, namely, *to digest the fleshy part of the food.*

(2.) The second use of the stomach is to be a *storehouse for the food.* It takes between two and three hours to digest an ordinary meal. If there were no large bag in which the food could be kept until digested we should have to keep eating little by little all the time. The large size of the stomach also allows the gastric juice to be mixed quickly and thoroughly with the food, and thus digestion takes place more quickly than it otherwise would.

(3.) Still another use of the stomach is to churn the food, and to roll it about so as to grind it into the smallest particles and mix it with the gastric juice. One of the coats of the stomach consists of muscle-tissue, and this coat causes these motions of the stomach. Besides, the lining of the stomach has a large number of raised lines or ridges (Fig. 41), which make the breaking-up of the food still easier.

Some of the lower animals, as the ox and cow, have *four stomachs*. Such animals swallow grass and hay without thoroughly chewing them. Afterward this food passes back into the mouth. It is then chewed over again, swallowed, and after passing through the series of stomachs, is finally digested.

The Discovery of How the Stomach Acts.—Many years ago, a Canadian named St. Martin was shot in the abdomen. He recovered with a permanent opening leading from the outside into the stomach, through which the doctors could watch and see what happened after eating. They found that ordinarily it took the stomach *from two to three hours* to finish its work, and to discharge what it could not digest into the small intestine or bowel. This man lived a great many years with the curious opening, and was quite strong and healthy.

Certain kinds of food require a longer time than other kinds for digestion, and hence we call them *heavy* or *indigestible ;* other food is digested very quickly, and is called *light*, or *easily digestible*. As examples of heavy food may be mentioned, hard-boiled eggs, pies, cheese, etc. As examples of easily digested food, there are milk, soft-boiled eggs, toast, broiled steak, etc.

Effect of Alcoholic Drinks upon the Stomach and the Digestion.—Animals seem to know by instinct what is good for them to eat; they leave poisonous leaves and berries alone. But human beings have to learn by experience. The stomach, however, seems to have an instinct of its own, and if something is taken into it that is not good for food, the muscles in the walls will usually contract and push it violently out by the act of vomiting. A person can take enough alcohol to kill him in a few hours, but the stomach generally throws it up. This is what usually happens when a boy takes strong drink for the first time.

People often seem to have less sense than dumb animals,

for although their own experience tells them that alcohol is poisonous, they will still persist in drinking it. The reason is because when they have begun taking it habitually they feel so restless and miserable without it that they must keep on. Anyone who wishes to have a strong stomach and good digestion all through life should heed the experience of others and avoid all alcoholic beverages. Six hundred physicians have testified that, according to their experience, the moderate use of strong drink is always unhealthy, even when the body is in a healthy condition. They say it does not do any good to the digestion, but interferes with that process, and evils which are usually attributed to other causes, often result from the habitual use of these drinks even by moderate drinkers.

Most people form the drinking habit slowly, and begin with small drinks, which they take to "warm them up," or to "ward off a cold," as they say, or because they are "treated." They do not take enough to produce nausea. The effect on the stomach is a warm, tingling sensation, which is not true warmth, but in reality a smarting, the same as when arnica, which is largely alcohol, is put on a cut. The thin, mucous membrane is reddened, because of the amount of blood drawn to the walls of the stomach. The alcohol causes the little blood-vessels to become congested. It hardens their walls and makes it difficult for them to absorb liquid. This does not happen all at once, but it goes on gradually with each small drink taken into the stomach. Nor is this all; if continued, the walls of the stomach become bright red instead of pink in color, and grow darker and darker red as the congestion of the blood-vessels increases. Catarrh of the stomach is a common result.

Chemical experiments in a test tube show that the action of alcohol on the digestive fluids is to destroy the effect of its active principle, the pepsin. This takes place in two ways, first by hardening the food, so that the gastric juice cannot separate it into small particles, and second by coagulating the

pepsin, which is the part that digests the food. To what extent this takes place in the stomach is not definitely known; but experiments in actual stomach digestion have shown that that process goes on very slowly, if at all, so long as the alcohol remains in the stomach, and that even small quantities of alcoholic drinks, such as have been supposed to "aid digestion," really prolong the process. When larger quantities are taken the food remains in lumps, which are apt to ferment. Sometimes it is passed off into the intestines in this condition, where it always does mischief, and sometimes it is thrown up out of the stomach. Naturally a stomach that has been treated so badly does not want any more food for several days. This is seen in a person who has been intoxicated. He has no appetite, but has intense burning headache and nausea, and must rest for a time just as if he had had an attack of illness.

Effect of Tobacco on the Digestion.—Tobacco, if taken into the stomach, is a severe poison, but people seldom die of it; it acts as an emetic, and thus the stomach gets rid of the poison. Inhaling tobacco-smoke also produces vomiting. This is why boys when they first begin to smoke are made sick at the stomach. Men, when they chew tobacco do not swallow the saliva containing the juice, for they would be made sick; therefore they are obliged to get rid of it in some other way, and so form the filthy and vulgar habit of spitting.

The poison in tobacco is called nicotine. Its effect is to paralyze the nerves and the muscles. In smoking, a very little nicotine is taken into the system, just enough to "soothe the nerves," the smoker says; but in reality enough to slightly paralyze them. It also paralyzes those muscles of the stomach that constantly turn the food over and over; therefore digestion is hindered. Physicians meet with thousands of cases of dyspepsia that have arisen from the use of tobacco; and a smoking man who consults a physician for dyspepsia is generally told that he must give up his cigars or cigarettes.

THE BOWELS, OR INTESTINES.

These consist of a long, hollow tube, about twenty-five feet long, commencing at the stomach (Fig. 36). Where stomach and intestines meet is a narrow opening, which is closed, except when the stomach has digested what it can of the food, and wishes to empty what is left into the intestines.

This narrowing is called, as has already been mentioned, the *pylorus*, meaning *gatekeeper*, and it will be seen that it is well-named, for it guards the outlet of the stomach. The remnants of food which the stomach refuses to digest pass this point in the form of a soft, creamy mass.

SUBDIVISIONS OF THE INTESTINES.

The intestines can be divided into three parts; the first part, which is next to the stomach, is called the *duodenum*, a long word, which was given to it in olden times because it is about as long as twelve fingers put side by side, so that this part of the bowel is quite short. The second part is very long —twenty feet—and forms the principal part of the bowels. It is called the *small intestine*, and the word small is used because it is narrower than the rest. The remainder of the bowels (about five feet long) is the last portion, called the *large intestine*, because it is wider than the rest.

The intestines are twenty-five feet long. In order that they may be contained in the abdomen they are folded together many times around a stem which is attached to the backbone. In this way they can move around somewhat, and yet they are kept in place by being held to the backbone. It will be seen later why it is necessary that they should be allowed a certain amount of motion so as to cause the food to move on.

The intestines have the same coats as the stomach.

There is on the outside a smooth, shining coat (the *peritoneum*). On the inside is a soft, smooth, velvety coat (the *mucous coat*). Between these two there is a coat formed of *muscle-fibres*, which run around the intestine in circles. There is much less muscle-tissue in the walls of the intestine than in those of the stomach.

The Peritoneum.—The shining outside coat of the intestine is very important, and is formed of the same layer of tissue that lines the whole abdomen. The whole inside of the abdomen and the outside of all the organs within it are covered with this smooth sheet of tissue which we call the *peritoneum*. This covering is necessary so that the organs can move one upon another without pain, injury, or friction. The smooth surface is always kept moist by fluid.

Motion of the Intestines.—The intestines are never quiet. They are in motion all the time. This motion resembles that of a worm, slow, gradual, and creeping. It is accomplished by means of the muscle-fibres which exist in the walls. The object of this motion is to propel the food along so as to spread it out and hasten the absorption of the liquid and nourishing portions of the digested food.

Projections on the Inner Surface of the Intestines.—The inner surface of the intestines looks pinkish and is velvety. It has a large number of *valves* or *ridges* (Fig. 44) running across it, which prevent the food from passing along too rapidly, so that all the nutritious portions may be absorbed. Besides these projections we find that the velvety appearance is due to the presence of millions of other very *small projections* (Fig. 45), which resemble hairs in shape, but are soft, and when looked at with the microscope are found covered with cells. We also find, when we examine the mucous lining of the intestines, a great many small tubes similar to those found in the stomach.

The Work of the Intestines.—The intestines finish the digestion of the food. They also afford a lengthy surface

over which the liquid and digested nutritious parts of the food can pass and be absorbed by the blood, which then brings them to different parts of the body. We found that a small part of starchy food is digested by the saliva and that the stomach digests the fleshy portions of the food. The intestines digest the rest, namely: (1) the larger part of *starchy food* which is not affected by the saliva, (2) the entire *fatty portion of the food*, and (3) any *remnants of fleshy food* which the stomach may have failed to act upon.

Starch cannot be taken up by the blood until it has

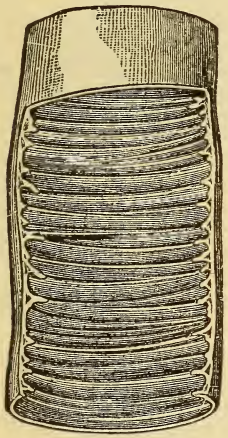


FIG. 44.—The Inner Surface of the Small Intestine, Showing the Valves or Ridges.

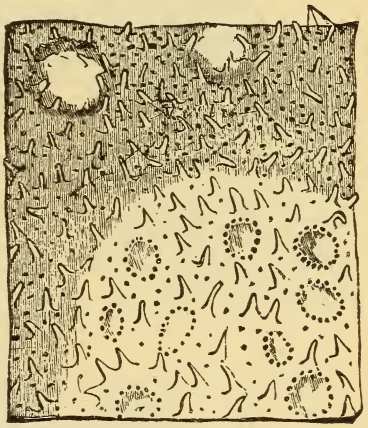


FIG. 45.—The Small Hair-like Projections from the Inner Surface of the Intestine. (Very highly magnified.)

become *changed into sugar*. Fat must also first become altered by fluids in the intestines before the blood can absorb it.

Openings into the Small Intestine.—The main work of the intestine takes place at the upper part near the stomach. Just below the stomach we find *two openings* leading into the part of the intestine known as the duodenum. One of these openings is the *canal from the liver and the gall bladder*,

the other is *the canal from the pancreas.* Previous to discussing digestion in general, the organs furnishing these two canals will be considered.

THE LIVER AND THE GALL-BLADDER.

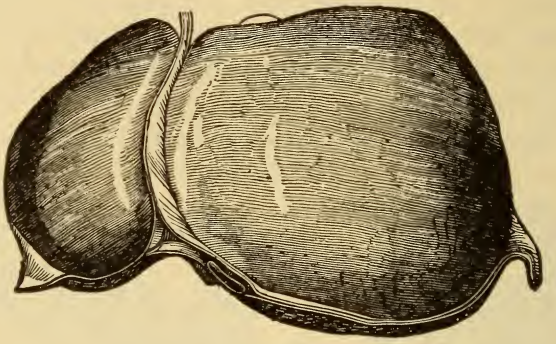


FIG. 46.—The Liver, Upper Surface.

The liver (Figs. 36, 46, and 47) is a large organ of a brownish color, placed in the upper part of the abdomen, to the right of the stomach. It is just below the diaphragm and the

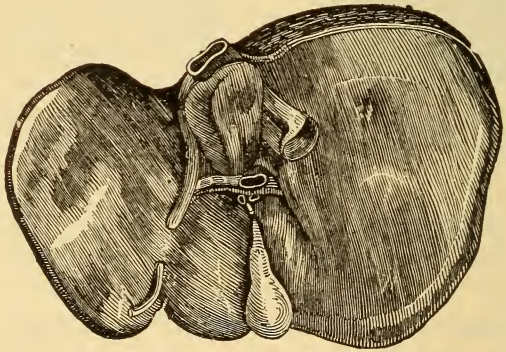


FIG. 47.—The Liver, Under Surface; Below, the Gall-bladder is Seen.

lower ribs, which cover it in front and above by forming an arch over it. The liver is very heavy; it is smooth on the outside,

and covered by the same smooth membrane which covers all the organs of the abdomen, viz., the peritoneum. It is subdivided by deep lines into five sections called *lobes.*

Uses of the Liver.—The liver is a very important organ. Its uses are,

(1.) To make the *bile.*

(2.) To *purify the blood* which passes through it.

(3.) To add a certain *nourishing body* to the blood which passes through it.

The Gall-bladder and Bile.—If we look at the liver under the microscope, so that it is very much enlarged, we shall see that it is formed entirely of small cells, like cubes, packed one against another (Fig. 48). These cells manufacture *the bile,* which is then collected by small tubes. Along the lower edge of the liver a bag about the size of an egg will be seen. This is called the *gall-bladder* (Figs. 36 and 47), and the tubes which collect the bile empty into it. This bag keeps the bile until it is wanted. The liver is making bile all the time and yet the intestines do not need it except when food is present; hence there must be such a storehouse.

FIG. 48. — The Liver-cells, Very Highly Magnified.

Action of the Bile.—After the stomach has finished its work and the changed food has passed into the intestine, the bile which has been stored up in the gall-bladder is allowed to escape into the intestine by a small tube leading to one of the two openings in the duodenum already described. The bile is of a green or brown color. We do not know precisely what the bile does to the food; but we are certain that bile must be mixed with it, for if it is absent a person cannot live very long. Sometimes bile gets into the blood and causes a yellow color of the skin, which we call *jaundice.*

There is a great deal of blood passing through the liver, which is *purified* in its passage by the removal of certain *unhealthy substances.*

After a meal there would be a great deal of nourishing matter thrown into the blood all at once ; and this would soon be used up, and then there would be no more until the next meal. In order to prevent this, the liver takes care of a large amount of sugar and *keeps it stored up,* and then gradually lets it return little by little into the blood.

Effect of Alcoholic Drinks upon the Liver.—A drunkard's liver, examined after death, always shows the effects of this poison. The liver becomes thoroughly diseased, and a portion of its tissue changed into fat, as a result of which the cells of the changed part no longer secrete bile. This disease is called "Fatty Degeneration of the Liver." It causes the liver to decrease in size.

Another disease is called hob-nailed liver, or gin-liver. The liver becomes puckered and yellow with bile, and the person has dropsy or swelling in the feet This disease is very common among drunkards, but very few others have it.

A person who is not a drunkard but who drinks a little liquor every day regularly is liable to have his liver out of order. He is apt to be bilious or constipated, or have trouble with his digestion, which means that the liver is not secreting the bile as it should.

THE PANCREAS.

This is one of the organs of digestion (Fig. 36). The pancreas of the calf is sold by the butcher as *sweetbread.* This organ is not large, but is very important. It is placed just below the stomach. Its work is to prepare a fluid called the *pancreatic juice.* This is made by cells, just as in the liver. Small tubes then collect the fluid and open into one large

tube which empties into the commencement of the small intestine.

Uses of the Pancreatic Juice.—The pancreatic juice digests all parts of the food which are left after the saliva and the gastric juice of the stomach have acted upon them. Thus it *digests fat* and *starch*, and it will also digest any of the *fleshy food* which the stomach has neglected to change. It is consequently a very important fluid.

ABSORPTION.

All the fluids of digestion just described—the saliva, gastric juice, and pancreatic juice—simply change the chewed food, so that the blood can take it up or *absorb* it as nourishment; and this action of these fluids is called *digestion*. There still remains to be seen how the blood absorbs this nourishment, and what it does with it.

If we look at one of the smallest blood-vessels (Fig. 53) it will be found that the walls consist of the very thinnest membrane, and that this allows fluids to pass through quite readily. In the lining of the stomach and intestines we find a great many of these tiny blood-vessels; as the food reaches these places and has become digested, it passes into the blood-vessels and is carried with the blood to the different parts of the body, to be used in forming and building up tissues which are constantly being consumed.

Lacteals.—Besides passing directly into the blood-vessels, the digested food also passes into certain other tubes of very small size, like blood-vessels, except that they do not contain blood. These small tubes are called *lacteals*, from a Latin word meaning *milk*, because the nourishing fluid which they carry and afterward add to the blood looks white, like milk, during digestion. These lacteals finally empty into large veins at the lower part of the neck (Fig. 62).

HABITS WHICH ARE INJURIOUS TO PROPER DIGESTION.

(1.) *Eating too rapidly.* When the food is eaten too rapidly it cannot be chewed properly, and the result is that it is swallowed in large pieces. The stomach has great difficulty in digesting these large pieces and thus *indigestion and dyspepsia* result if the practice be continued.

(2.) *Eating too much at a time.* This gives the organs of digestion too much work to do, and on this account all the food cannot be digested. We should not continue to eat until we feel heavy and uncomfortable, but should stop before we feel this way.

(3.) *Eating too many sweets and sours.* While a pickle occasionally at meals, or candy and cake now and then, will do no harm, if these things are taken constantly they are injurious, because they destroy the appetite for nourishing food.

(4.) *Chewing gum* gives the salivary glands too much work, and thus the saliva soon becomes too thin and does not act as it should.

(5.) *A large amount of ice-water.* A little ice-water, taken slowly, will do no harm, whether during meals or at other times; but to drink down a gobletful rapidly when the body is heated is very unhealthy, as it chills the stomach and delays digestion.

(6.) *Violent exercise immediately after a meal.* This should not be indulged in, for at that time the stomach needs all the blood it can get; and violent exercise drives too great a proportion to the muscles.

(7.) *Severe brain work* directly after meals is not good.

(8.) *Bathing* should not be indulged in within two hours after an ordinary meal.

(9.) *Excitement of any kind,* as good news or bad news just before a meal, usually takes away our appetite. If we eat, nevertheless, the food will not be digested, or only very imperfectly.

(10.) *Alcoholic drink* makes food less digestible, especially if it be strong drink; and it also irritates the stomach needlessly.

(11.) *Smoking* will destroy the appetite and interfere with digestion in many persons.

THE SPLEEN.

The *spleen* (Fig. 36) is not one of the organs of digestion; but its description will be given at this place, because it is placed in the abdomen. It is a round, flattened organ, solid, and contains a great deal of blood. It is found on the left side of the abdomen just underneath the lower ribs. Its use is not exactly known; but lately, however, it has been thought to take part in supplying the globules to the blood. It becomes enlarged in all malarial diseases, and then sometimes reaches an enormous size.

SYNOPSIS.

Digestion—The changing of the food and its liquefaction, so that the blood can absorb it.

Organs of Digestion: Mouth.
Teeth.
Salivary Glands.
Tongue.
Throat.
Gullet.
Stomach.
Intestines. { Duodenum. / Small Intestine. / Large Intestine. }
Liver.
Pancreas.

Mouth—To chew the food and mix it with saliva.

a. Tongue—Assists in mixing food with saliva and in swallowing.

b. Teeth:

1. { *a.* Temporary or milk teeth—ten in each jaw. / *b.* Permanent—sixteen in each jaw.

Four incisors.
Two canine.
Four bicuspid.
Six molars.

2. Divisible into

a. Parts : { Crown. Neck. Root.

b. Structure : { Enamel. Dentine. Pulp (cavity).

3. Care of—Should be kept clean.
Brushing.
Toothpicks.
Improper use.
Tobacco.

c. Salivary Glands :

1. Location :
(1.) Parotid—In front and below ear.
(2.) Sublingual—Below tongue.
(3.) Submaxillary—Below jaw.

2. Saliva.
(1.) Produced during chewing.
(2.) Moistens food.
(3.) Digests a part of starchy food.
(4.) Keeps mouth moist.
(5.) Watery, clear fluid.
(6.) Necessity for thorough chewing.
(7.) Effect of chewing gum.

Throat :

1. Between mouth and gullet.
2. Concerned in swallowing.

Tongue :

1. Mixes food with saliva.
2. Assists in swallowing.
3. Organ of taste.

Gullet or Œsophagus :

1. Connects throat and stomach.
2. Formed of rings of muscle-tissue.
3. These force food into stomach.

Stomach :

1. Position—Upper part of abdomen, just below diaphragm.
2. Openings—One for entrance of food ; other (pylorus) into intestines.
3. Coats :
   (1.) Outer—Peritoneum.
   (2.) Middle—Muscle-tissue.
   (3.) Inner—Mucous membrane.
4. Uses :
   (1.) To secrete gastric juice, which—
      a. Is formed during digestion.
      b. Digests fleshy food.
      c. Contains pepsin.
      d. Is formed in the gastric tubules.
   (2.) A storehouse for the food.
   (3.) To churn the food and break it into small particles.
5. Effects of alcohol and tobacco—Alcohol irritates, tobacco sickens.
6. Discovery of action—St. Martin ; opening in stomach.
7. Digestibility—Heavy and light food.

The Intestines :

1. Connection with stomach—By pylorus.
2. Subdivisions :
   a. Duodenum.
   b. Small intestine.
   c. Large intestine.
3. Length—Twenty-five feet.
4. Attachment—To backbone.
5. Coats—Same as stomach :
   a. Outer or peritoneum.
   b. Middle or muscle tissue.
   c. Inner or mucous membrane.
6. Motion—To propel food and digested fluids.
7. Projections from inner surface :
   a. Valves or ridges.
   b. Hair-like projections.
8. Function :
   a. Digest starchy food.

b. Digest fatty food.
c. Digest remnants of fleshy food.

9. Openings :
a. From liver and gall-bladder.
b. From pancreas.

The Liver and Gall-bladder :

1. Position—Upper part of abdomen, to right of stomach.
2. Description—Large, solid, brownish, subdivided into five sections or lobes.
3. Uses :
a. To make bile.
b. To purify the blood.
c. To add nourishment to the blood ; storehouse.
4. Bile :
a. Color—Greenish or brownish.
b. Action—Not exactly known.
c. If gets into blood—Jaundice.
5. Unhealthy Liver—From too rich food, alcoholic drinks, too little exercise ; Gout.
6. Drunkard's Liver—Too large or too small.

The Pancreas :

1. Position—Just below stomach.
2. Use—To form pancreatic juice, which—
a. Digests fat.
b. Digests starch.
c. Digests remains of fleshy food.

Absorption—The taking up of digested food in fluid form by the blood and lymphatics :

1. By blood-vessels.
2. By lymphatic vessels.
3. By lacteals.

Habits Injurious to Proper Digestion :

1. Eating too quickly.
2. Eating too much at a time.
3. Eating too many sweets and sours.
4. Chewing gum.
5. Ice-water in large amount.
6. Violent exercise immediately after meals.

7. Severe brain-work immediately after meals.
8. Bathing after meals.
9. Excitement before, during, or after meals.
10. Alcoholic drink.
11. Smoking or chewing tobacco.

The Spleen:

1. Description—Round, flattened, solid organ full of blood.
2. Position—Left side of abdomen, underneath lower ribs.
3. Use—Probably to supply globules to the blood.
4. Enlarged—In malarial diseases.

QUESTIONS.

1. What is meant by the word digestion? 2. Name the organs of digestion? 3. What are the teeth for? 4. What are the temporary teeth? 5. When do we begin to have our permanent teeth? 6. How many permanent teeth are there in each jaw? 7. What are the parts of each tooth? 8. Are the teeth solid or hollow? 9. What names are given to the different teeth? 10. Which are the incisor teeth, what is their shape and their use? 11. What is peculiar about the canine tooth? 12. What about the bicuspid teeth? 13. What about the molar teeth? 14. Of which three parts does each tooth consist? 15. What is the proper way of taking care of the teeth? 16. What effect has tobacco on the teeth? 17. What are the salivary glands? 18. Where are they found? 19. What is their use? 20. What is saliva? 21. What are the uses of saliva? 22. What are the effects of chewing gum upon the saliva? 23. Where is the gullet? 24. Where does it lead to? 25. What is the shape of the stomach? 26. Where is it placed? 27. What openings are there in the stomach? 28. What coats are there to the wall of the stomach? 29. How does the inside of the stomach look when it is empty? 30. How does it look when food enters the stomach? 31. What is the gastric juice? 32. How is the gastric juice made? 33. Of what use is the gastric juice? 34. When does the gastric juice flow? 35. What kind of food is digested by the gastric juice? 36. What is pepsin? 37. What are the three uses of the stomach? 38. Have any animals more than one stomach? 39. How does the ox digest hay? 40. What effects have tobacco and alcohol upon the stomach? 41. How was the way in which the

stomach acts in man discovered? 42. What is meant by heavy food? 43. What is meant by light food? 44. Give examples of each. 45. What is another name for the bowels? 46. How long are the bowels? 47. How do the bowels connect with the stomach? 48. What kinds of food are still undigested when they leave the stomach? 49. What is the pylorus? 50. Into what three parts can the intestines be divided? 51. What is the name given to each part? 52. How are the intestines arranged so that they can all find room in the abdomen? 53. To what are the intestines attached? 54. What coats have the intestines? 55. What can you say about the outside shining coat of the intestines? 56. What is the peritoneum, and what does it cover? 57. Tell about the lining of the intestines. 58. What is the work of the intestines? 59. What kinds of food are digested by the small intestine? 60. In what part of the small intestine does most of the work take place? 61. What openings are there into the first part of the small intestine? 62. Where is the liver placed? 63. What are the three uses of the liver? 64. Where is the gall-bladder? 65. How is bile made? 66. What does it look like? 67. When is bile needed in the intestine? 68. How does the bile get into the intestine? 69. What can you say of the uses of bile? 70. What is jaundice? 71. How does the liver become diseased? 72. What is the cause of gout? 73. What effect has alcohol upon the liver? 74. Where is the pancreas? 75. What is it commonly called by the butcher? 76. What fluid is produced by the pancreas? 77. What are the uses of the pancreatic juice? 78. What kinds of food are digested by the pancreatic juice? 79. How does the blood take up the nourishing parts of the food which have become digested? 80. What are the lacteals, what do they do, and why are they so-called? 81. Are the intestines usually quiet or in motion? 82. Why is it necessary for them to be in motion? 83. Mention some of the habits which are injurious to digestion? 84. Explain why eating too quickly or too much at a time is injurious. 85. How should ice-water be taken? 86. Why should we not exercise directly after meals? 87. What effect has excitement of any kind upon digestion? 88. What effect have alcohol and alcoholic drinks upon digestion? 89. Where is the spleen? 90. What does it look like? 91. What do we know about its use?

CHAPTER X.

THE ORGANS OF VOICE AND BREATHING.

Another name for breathing is *respiring*, and hence the act of breathing is called *respiration*. When air is taken into the lungs we *breathe* IN or IN*spire;* when the air passes out again, we *breathe* OUT or EX*spire*.

Course of the Inspired Air.—When we inspire, the air first passes through the *nose*, then into the *throat*, next into the sound-producing organ in the neck, the *larynx*, then it passes through a tube running down the front of the neck, called the *trachea* or *windpipe*, which leads to the *lungs*.

Each one of these parts will require special study. The nose will be left until the study of the sense of smell is taken up. The throat has already been discussed in the chapter on digestion (Chapter VI.).

THE ORGAN OF VOICE—THE LARYNX.

The organ which produces sound is called the *larynx*.

Form and Situation of the Larynx.—The larynx is a triangular box (Figs. 63 and 69) the walls of which are formed of gristle, or cartilage. It is placed at the upper and front part of the neck, and can readily be felt as a hard prominence just below the chin.

Parts of the Larynx.—The larynx is formed of several pieces of cartilage joined together. The principal part is formed by a large *triangular piece* which is prominent and pointed in front, and can be felt beneath the skin. This

pointed portion is called *Adam's apple*, and is larger in men than in women, and in some persons it stands out very much.

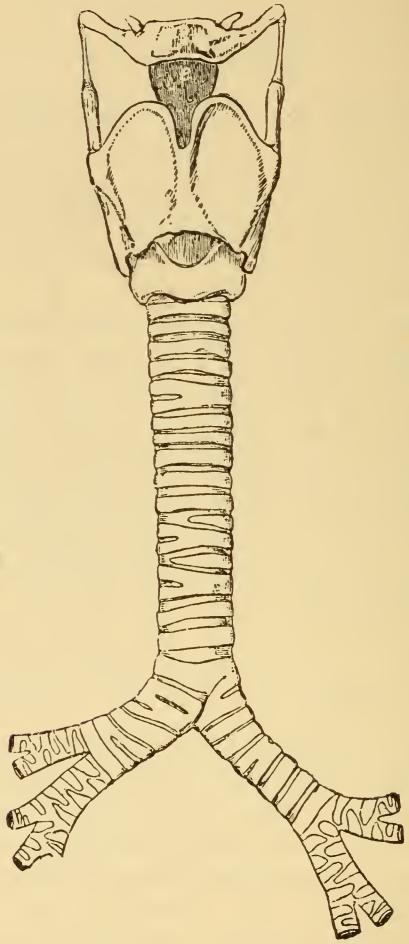


Fig. 63.—The Larynx, the Trachea or Windpipe, and the Bronchi.

Just above this triangular cartilage of the larynx, and covering up its upper opening somewhat, is another piece of cartilage,

called the *epiglottis*. Below the triangular cartilage is a *circular* piece of cartilage which resembles a seal-ring in shape. These three pieces of cartilage, the triangular, the circular, and the epiglottis, form the main part of the larynx, though there are a few smaller pieces.

Epiglottis.—This is the name given to the piece of cartilage, shaped like a leaf, which covers over the top of the larynx when we swallow. Usually it stands up straight, but in swallowing it is pressed down over the top of the larynx, and then the food slides over it into the gullet. If it be remembered that the larynx is placed in front, and that the food must pass across it (Fig. 67), it will be seen how important such an arrangement is; but as will soon be explained, there is another way in which the food is prevented from going into the larynx and windpipe.

The Vocal Cords.—If we look into the larynx, we shall find that there is a shelf projecting on each side (Figs. 64, 65, and 66) and that these two shelves can be moved; sometimes they move toward the middle and meet each other, at other times they separate, and then there is a large space between them. These are called the *vocal cords*, because they produce the voice-sounds by their motion.

Protecting the Windpipe.—The vocal cords are found at the upper part of the larynx; when they come together tightly, they close the larynx completely, so that nothing can pass into it. This is what they do whenever any food or solid body tries to get into the larynx or windpipe. It will be seen how necessary this is, for otherwise we should always be in danger of being choked. Sometimes the food is swallowed unexpectedly, and the vocal cords forget to close; then we say the food has *gone down the wrong way*. This is very distressing, causing coughing until the piece of food is dislodged. In speaking or laughing during meals, care should be taken that the mouth be not full, otherwise this accident may happen.

The Vocal Cords in Breathing.—When we *inspire*,

the vocal cords *separate* widely, so as to let the air pass readily into the windpipe and into our lungs (Fig. 64). When the air passes out (*expiration*), the vocal cords again *come together*, but

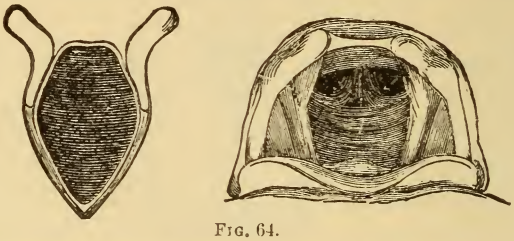


FIG. 64.

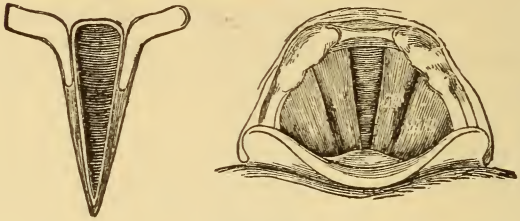


FIG. 65.

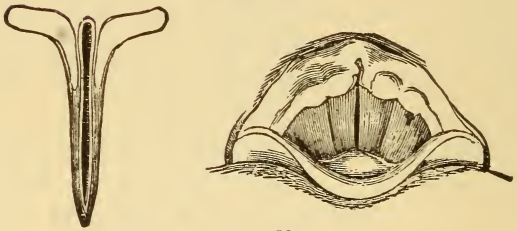


FIG. 66.

FIGS. 64, 65, and 66.—Showing the Position of the Vocal Cords in Breathing and in Using the Voice. In Fig. 64 the cords are widely separated, as they are in inspiration; in Fig. 65 the cords are slightly separated, as they are in expiration; in Fig. 66 the cords are brought together closely, as they are when sounds are produced.

not tightly, there being still some space left between the two (Fig. 65).

How Sounds are Produced.—Previous to making a sound we usually take a deep breath. Then this air is blown out again, and as it passes through the larynx, between the vocal cords, it makes these vibrate, and through the rapid mo-

tion of the vocal cords, sound is produced. There are many differences in the quality of the human voice, being coarse in some, sweet in others, high in some, low in others. Then there are other peculiarities of the voice, by which we recognize our friends by hearing them speak.

It depends very much upon how the vocal cords are placed what kind of sound is produced. If the vocal cords are brought closely together and are made very tight the sound will be high. If you could look into the larynx of a lady with a soprano voice, while she is singing, you would find the vocal cords very close together; if, on the contrary, the sound is produced while the cords are further apart and less tense, the sound will be low, like that of a bass voice.

Speaking.—Although sound is produced in the larynx, it is changed by other parts, principally the throat, the mouth, the tongue, and the lips. These change the sound so that words are spoken. With the vocal cords alone we could make sounds as in singing; but to speak, we must change these sounds by means of the parts already mentioned. For instance, in pronouncing the word paper, the manner in which the lips come together will be noticed; if the word law be pronounced, the tongue will touch the top of the mouth.

THE TRACHEA, OR WINDPIPE.

Situation and Form.—If the finger be passed along the front of the neck, from the larynx downward, a hard tube can be felt and traced down to the top of the breast-bone; and then it can no longer be felt, for it passes behind this bone into the chest. This hollow tube is called the *windpipe*, or *trachea* (Fig. 63). It serves to conduct the air to the lungs, after it has passed through the nostrils, nasal passages, throat, and larynx.

The Air-passage and the Food-passage.—The existence of another tube running along the middle of the neck —the *œsophagus* or *gullet*—has already been mentioned in the

chapter on Digestion. Its purpose is to carry the food to the stomach after it has been chewed in the mouth and swallowed. The windpipe is placed in front of the gullet (Fig. 67); and both of these tubes pass into the chest. The windpipe then passes to the lungs. The gullet passes through an opening in the diaphragm and connects with the stomach in the abdomen.

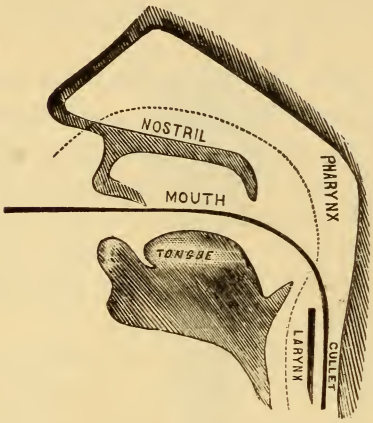


FIG. 67.—The Air-passage and the Food-passage. The heavy line indicates the course of the food through mouth and gullet; the dotted line shows the course of air through nostril into pharynx, and then into the larynx and trachea, which are placed in front of the gullet.

Rings of the Windpipe.—The windpipe is formed of a large number of rings of gristle, joined together by a thin membrane (Fig. 63).

Branching of the Windpipe.—After having passed into the chest for a short distance, the windpipe divides into two smaller tubes (Figs. 63 and 69). These branches are called the *bronchi*, there being two of them, a *right* and a *left bronchus*. Each carries the air from the windpipe to the corresponding lung, the right bronchial tube naturally passing to the right lung, and the left to the other side.

THE LUNGS.

The lungs are the organs with which we breathe. There is (Figs. 68 and 69) a *right lung* and a *left lung*. Between these two the heart is placed (Fig. 68). The lungs and the heart fill up the entire space in the chest.

Shape of the Lungs.—Each lung is shaped somewhat like a cone, with the apex above and the base below (Fig.

69). The lungs are very light and contain a great deal of air, and float when placed on water. Even after squeezing out all the air we can, there will still be a considerable quantity remaining in the lung.

Structure of the Lungs.—If we cut into the lungs, we find they are formed of a large number of tubes and

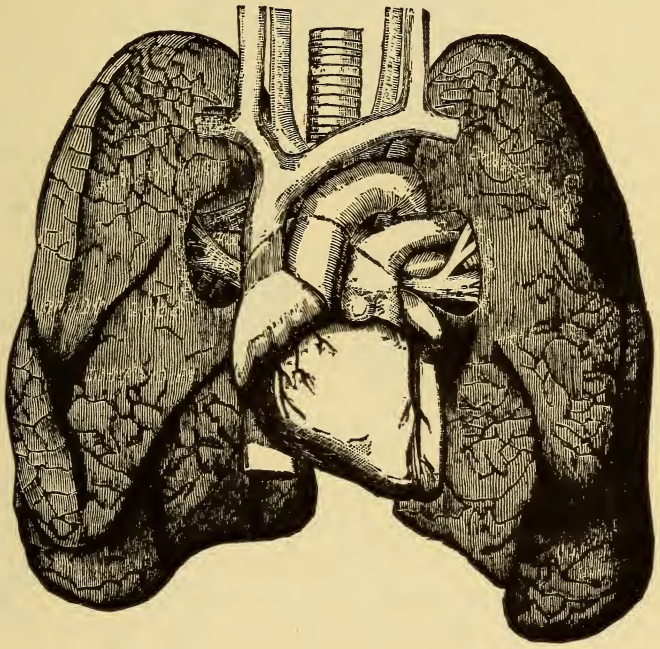


FIG. 68.—The Heart and Lungs. On each side the lungs are seen; in the centre is the heart; above are the windpipe and the large blood-vessels passing to and from the heart.

spaces containing air. After entering the lungs, each bronchus divides again and again (Fig. 69), each branch, known as a bronchial tube, becoming smaller, until finally the branches of each bronchial tube have become so small that they can no longer be seen without the microscope (Fig. 70, *a*).

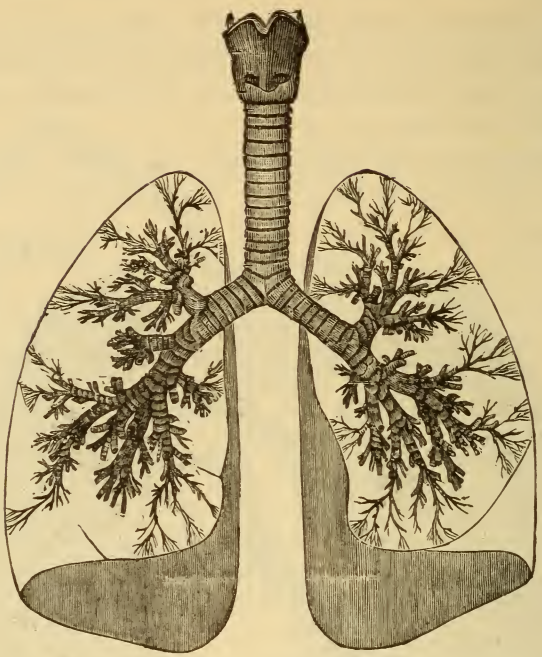


FIG. 69.—The Larynx, Trachea, Right and Left Bronchus, and the Lungs. The latter have been cut open to show the method of division and subdivision of the bronchi.

The Air-Vesicles.—The smallest branch of a *bronchus* (Fig. 70, *a*) swells so as to end in a little bag containing air, called an *air-space* (Fig. 70, *b*). The walls of these air-spaces are again subdivided so as to form a large number of small sacs called *air-vesicles.* The walls of these air-vesicles are very thin and contain many blood-vessels. From this description it will be seen that the lungs really consist of a great collection of small sacs or spaces filled with air.

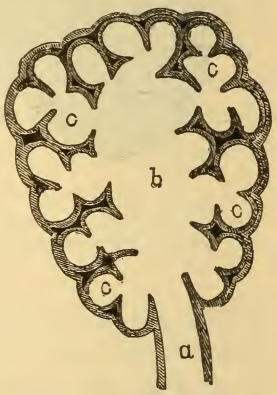


FIG. 70.—The Air-vesicles. *a*, The smallest branch of the subdivisions of a bronchial tube; *b*, the dilated passage or *air-space*, into which this expands; *c*, the smallest spaces, *air-vesicles.*

The Pleura.—Upon their surface the lungs are covered with a sheet of smooth membrane, called the *pleura*, which also lines the inner surface of the chest. This smooth membrane allows the lungs to rub against the wall of the chest without pain or friction. The pleura resembles the peritoneum of the abdomen and serves a similar purpose.

Breathing is Involuntary.—Like the beating of the heart, breathing takes place without the use of our will-power. It continues whether we are awake or asleep, and even when we are unconscious. It is possible to breathe faster than usual for a little while, or to hold the breath for a very short period, but these are merely temporary changes which cannot be continued, for breathing is not under the control of the will.

Movements of the Chest in Breathing.—In inspiration air is taken in which passes to the lungs and expands them. Watching the chest while this is taking place, it is found that the ribs rise and that the chest becomes wider. In expiration, the air is allowed to pass from the lungs, these becoming smaller; the ribs fall and the chest again becomes narrower. When the lungs are filled with air, they press down the diaphragm; and this then crowds down upon the organs contained in the abdomen, which are pushed out; hence the bulging of the abdomen in inspiration.

Mouth-breathing.—In breathing, the air should be drawn *through the nose* and not through the mouth. Many children breathe through the mouth—an injurious practice which results in keeping the mouth open constantly, giving rise to a stupid expression of the face and allowing the air to reach the lungs in an improperly warmed and impure condition.

Frequency of Breathing.—Usually we breathe about *twenty times a minute.* Young children breathe oftener. After exercise, we breathe oftener than twenty times per minute. When asleep, we breathe less frequently.

Changes which Breathing Produces in the Blood and Tissues.—It has already been stated that the object of breathing is to purify the blood. How this is done has also been explained. But the subject is so important that it will be well to review it briefly. The air passes into the air-spaces of the lungs. In the thin walls of these air-spaces there is a large number of very small capillaries. In this way the blood in the capillaries is separated from the air by very thin tissue only, and gases can pass from the air to the blood and from the blood to the air very readily. In breathing, the blood takes oxygen from the air, and in exchange it gives it the poisonous carbonic acid gas, moisture, warmth, and a second poisonous gas which will be described shortly.

Changes Produced in the Air by Breathing.—While the air passes through the lungs it has *oxygen taken from it*—this is the first change. The second change is that it *receives* some of the *poisonous carbonic acid gas* from the blood. Third, it takes *moisture* from the blood. If you breathe upon the window-pane you can easily see this moisture; and in winter when it is cold you can notice the moisture in the air which we expire, because it becomes visible as soon as it meets the cold air. Fourth, the air which we exhale is *warmer* than that which we inhale, because it has taken some of the heat from the blood.

Finally, the air takes from the blood a certain *poisonous gas* which has a *disagreeable smell.* The exact nature of this unnamed gas is not known, but it is thought to be a mixture of many gases. It is known by its smell. If you come from the open air into a crowded room you find it disagreeable to breathe for a little while, because the air does not seem fresh; and you call it *close*, and if it is very bad you say it is *foul.* It is this bad-smelling gas which gives this odor. It is fortunate that this exceedingly poisonous gas has a bad smell, for otherwise we should not know that the air was no longer fresh and needed changing. If we stay in such a close room for a little while, we

no longer notice the smell, because we have become accustomed to it.

Effects of Impure Air.—Much time spent in close rooms produces a sleepy, dull, and tired feeling; the complexion suffers and we no longer look so bright as we did. The blood cannot be purified in such bad air. In this way all the tissues of the body become pale and weak, and the organs no longer work as they should.

Purification of the Air.—If the air is constantly being made impure by our breathing, it would seem quite natural to ask: Why is it that the air does not become so impure after a while that we cannot live in it? This would result if God had not provided two great purifiers—*sunlight* and *plants*. These are the great *natural purifiers* and change the bad air, making it as good as it was before. You have no doubt noticed how stale it smells in all dark places, such as cellars. This is because the sunlight never enters to purify the air.

The way in which the *plants purify the air* is still more wonderful; they make use of the poisonous gases as their *food*. Carbonic acid gas is necessary for plants to live and grow. Let us stop to consider how plants live and grow:

How Plants Live and Grow.—Plants *breathe in poisonous gases* from the air and *breathe out pure oxygen*. Besides the poisonous carbonic acid gas which they take from the air, they also absorb moisture and salts from the ground. From all these plants form their stems and leaves, and they grow until we could hardly believe that the big tree has grown from a small plant with no other nourishment than what has just been mentioned. In order to do this, plants must have *sunlight*—they will not grow in the dark. So that what is poisonous to the animal is food to the plant. And in this way pure oxygen is returned to the air and the poisonous carbonic acid gas is gotten rid of.

Ventilation.—Ventilation means allowing impure air to escape from our rooms and letting fresh air take its place.

This is very necessary. We have already spoken of the effects of impure air. If a man were locked in a room and everything were tightly closed so that no fresh air could enter, no matter how much food and drink he had, he would soon die, because his breathing would be constantly making the air of the room more and more impure, and finally he would die from want of pure air.

In the summer it is quite easy to ventilate our rooms, for all we need to do is to open the windows wide and the fresh air will stream in and the impure air escape at the same time. But in the winter it is more difficult; for the outside air, while it is fresh and pure, is also cold; and if we opened the windows very wide we should feel cold. It is fortunate that our windows are not, as a rule, very tight fitting; hence more or less air gets in through the cracks. But it is well to draw down the window a little from the top, for the foul air is lighter than the fresh air and is always found near the ceiling of the room.

Another very good way of ventilating a room is to push up the lower window about six inches and to fasten a piece of board in front of the open space which you make in this way. Or instead of a board a piece of canvas will be better yet, and it can be made to look nice by painting or embroidering on it. In this way the fresh air will come in through the canvas below, and the foul air will go out in the opening between the upper and lower portions of the window, as is shown in Fig. 71. Certain methods of heating rooms are also valuable as means of ventilating them. The open-grate fire is one of the best means of supplying warmth, because it furnishes such a ready escape for the impure air, which passes up the chimney.

In ventilating rooms it must be remembered that there should be no draughts of air upon the persons in the room, for otherwise they will catch cold. And also that a room cannot be healthy if no sunlight ever enters it. In some of our houses

nowadays, and especially in what we call flats, many of the rooms are dark and never have any sunlight, and must be

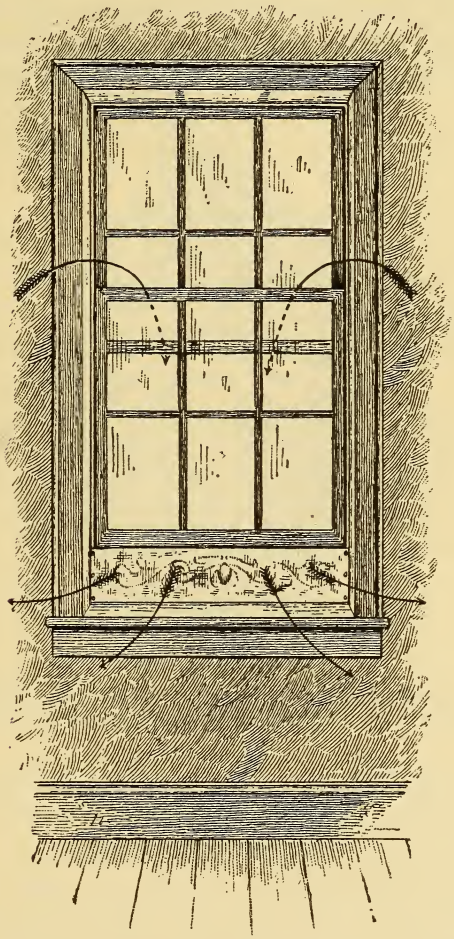


FIG. 71.—A Ready Method of Ventilating Rooms. The arrows above indicate the escape of the impure air; those below, the entrance of fresh air.

unhealthy, as the air in them can never be so pure as in light rooms.

Effect of Tight Clothing upon Breathing.—Tight clothing presses upon the chest, and does not allow the lungs to expand as they should; in this way not enough air can enter the lungs and the blood suffers, and from this also the rest of the body. Besides, if children dress so tightly about the chest, it will keep the chest from getting its proper

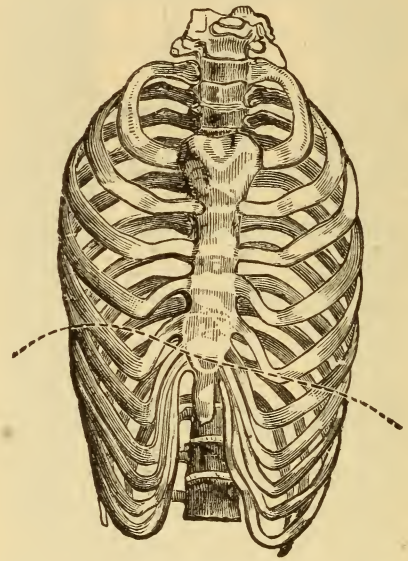


FIG. 72.—A Deformed Chest, the Result of too Tight Clothing. Compare with the natural chest shown in Chapter II., Fig. 18. The dotted line indicates the position of the diaphragm.

shape and size (Fig. 72). We should try to have as broad a chest as possible, and should always remember to throw our shoulders back, and to sit and stand erect.

Effect of Alcoholic Drinks on the Lungs.—As every breath we draw unloads the body through the passage-way of the lungs, of carbonic acid gas and organic impurities of the blood, and takes in a fresh supply of oxygen, if anything happens to irritate the spongy cell-tissue of the lungs they are prevented from working well.

The alcohol which passes off in the breath, giving it that very foul odor peculiar to a drinking man's breath, has to pass through the cells of the lungs, and in so doing irritates and congests them ; this, in time, changes the delicate tissues of the lungs and renders it more difficult for the interchange between the carbonic acid gas and oxygen to take place. Impurities, therefore, accumulate in the body.

Lung-cells that are frequently irritated and weakened by alcohol lose their tone, and sudden exposure or disease finds them unprepared to resist it. Pneumonia and consumption are terrifying diseases to the physician when his patient is a man in the habit of drinking liquor, for he has small chance of saving him. Not only is the chance of life lessened when these diseases attack one, but a man who drinks is in greater danger of contracting them.

An authority on the subject writes : "There is no form of consumption so fatal as that from alcohol. Medicines affect the disease but little, the most judicious diet fails, and change of air accomplishes but slight real good. It may be delayed in its course, but it is never stopped ; and not infrequently, instead of being delayed, it runs on to a fatal termination more rapidly than is common in any other type of the disorder."

Effect of Tobacco upon the Throat and Vocal Cords.—Tobacco smoke so irritates the delicate membranes of the throat and bronchial tubes that many people coming into a room where others have been smoking are seized with a fit of coughing that will not stop until they get pure air. Much more does the inhaling of smoke by the smoker himself irritate the membranes. "Smokers' sore throat" and "smokers' tongue" are familiar diseases to the physician.

The vocal cords are reddened and thickened, and the voice rendered husky. Great singers avoid the use of tobacco, and orators and public speakers find that if they want their voices to be strong and rich-toned they must not injure them by either strong drinks or tobacco.

SYNOPSIS.

The Organ of Voice—The Larynx :

1. Form—Triangular box.
2. Structure—Walls formed of cartilage.
3. Situation—Upper and front part of neck, just below chin
4. Function :
    a. Passage of air to windpipe and lungs.
    b. Production of sound.
5. Parts :
    a. Triangular piece (including Adam's apple).
    b. Circular piece.
    c. Epiglottis.
    d. Vocal Cords :
        (1.) Protect windpipe.
        (2.) Move in respiration.
        (3.) Produce the voice-sounds by their vibration

The Organs of Breathing :

1. Larynx.
2. Trachea or windpipe.
3. Right and left bronchus.
4. Lungs.

Trachea :

1. Situation—Along front of neck in middle line.
2. Form—Cylindrical tube.
3. Structure—Rings of cartilage joined together by membrane.
4. Function—Conveys air from larynx to lungs.
5. Branches—Right and left bronchus.

The Lungs :

1. Situation—The cavity of the chest, on each side of the heart.
2. Form—Cone-shaped, with apex above.
3. Function—To purify the blood by allowing it to be brought in close contact with the air.
4. Divisions—Right and left lung.
5. Structure :
    a. Bronchial tubes.

b. Air-spaces.
c. Air-vesicles.
d. Pleura, covering outside.

Breathing:

1. Is involuntary.
2. Accompanied by certain movements of chest:
   a. In inspiration, chest becomes wider and ribs rise.
   b. In expiration, chest becomes narrower and ribs fall.
3. Frequency—About twenty per minute; more frequently in young children and after exercise.
4. Changes produced in blood:
   a. Gains oxygen and becomes brighter.
   b. Loses carbonic acid gas, other poisonous gas, moisture, and heat.
5. Changes produced in air:
   a. Loses oxygen.
   b. Has added:
      (1.) Carbonic acid gas.
      (2.) Poisonous ill-smelling gas.
      (3.) Moisture.
      (4.) Warmth.
6. Effects of impure air:
   a. Poor health.
   b. Sleepy, dull, and tired feeling.
7. Effects of bad habits:
   a. Mouth-breathing; stupid expression; air improperly warmed and cleansed.
   b. Tight clothing about chest; deformed chest.
   c. Effect of alcohol on lungs; irritates; causes disease.
   d. Tobacco smoke; cough; sore throat.

Purification of the air:

1. Natural:
   a. Sunlight.
   b. Plants, by using the carbonic acid gas as part of their food and giving back oxygen to the air.
2. Artificial—affecting dwellings; ventilation.

QUESTIONS.

1. What is the meaning of the word respiration? 2. What is the definition of to inspire? 3. What is the definition of to expire? 4. Through what different parts does the air pass before it reaches the lungs? 5. What is the organ of voice called? 6. Where is the larynx? 7. What is its shape? 8. How is it formed? 9. What is Adam's apple? 10. What is the epiglottis? 11. Of what use is the epiglottis? 12. What are the vocal cords? 13. How do they protect the larynx and the windpipe? 14. How do we prevent food from going the wrong way? 15. How do the vocal cords move in breathing? 16. How is sound produced? 17. What makes the difference in the kind of sound produced? 18. In what position are the vocal cords in singing high notes? 19. In what position in breathing? 20. What other parts change the sound in speaking? 21. Could we speak with the larynx alone? 22. How can you prove that the lips and the tongue take part in speaking? 23. Where is the windpipe? 24. What is another name for it? 25. Where does it lead to? 26. What tube runs along together with the windpipe? 27. Which is in front, the windpipe or the gullet? 28. How is the windpipe formed? 29. Where does it end and what becomes of it? 30. What are the bronchi, and where do they go to? 31. What are the lungs? 32. Where are they? 33. How many are there? 34. What is the shape of each? 35. Are they light or heavy? 36. Why are they so light? 37. How are the lungs formed? 38. What are the air-spaces? 39. What are the lungs covered by on the outside? 40. Do we use our will-power in breathing? 41. Can we stop breathing when we want to? 42. How do we breathe? 43. What change do we see when we look at the chest while we are breathing? 44. What change if we look at the abdomen? 45. Should we breathe through the mouth or through the nose? 46. How often per minute do we usually breathe? 47. What difference is there when we exercise? 48. When we are asleep? 49. What changes does breathing produce in the blood? 50. Where and how do these changes occur? 51. What changes are produced in the air by breathing? 52. What is taken from the air? 53. What is given to it? 54. What poisonous gases are added to the air by breathing? 55. What makes rooms

smell close and foul when many people are in them and they are not properly aired? 56. What are the effects of impure air? 57. How is the air purified? 58. What are the two great purifiers of nature? 59. How do plants purify the air? 60. What does the food of plants consist of? 61. Can plants thrive without sunlight? 62. What is ventilation? 63. Could we live in a room if the air were not changed? 64. What is a good method of ventilating rooms in winter? 65. In what part of the room do we find most of the impure air? 66. Why are cold draughts undesirable? 67. What effect has sunlight upon the air of a room? 68. Can a room into which the sun never shines be healthy? 69. What effect has tight clothing around the chest upon breathing? 70. What effect has alcohol on the lungs? 71. What effect has tobacco-smoke upon the lungs? 72. What effect has it upon the throat?

CHAPTER XI.

THE HEAT OF THE BODY.

Have you ever stopped to think how it is that on the coldest day in winter our bodies remain warm, even though we go out into the open air? It may be necessary to have a big fire in our rooms, but still our blood remains just as warm as in summer. You may say it is due to the clothing we wear, but this is not so. For if you took a cold stone and wrapped ever so much clothing around it, you could not warm it. Our clothes keep in the heat of the body, but they cannot produce any.

The Body may be Compared to a Stove.—We can compare the human body to a stove, for there is some resemblance in the manner in which heat is produced. The food which we take in by the stomach and the air which we breathe combine to form the fuel, just as coal and wood form the fuel in the stove. This human fuel is then received by the organs of digestion, and changed and liquefied, so that it can be used by the various parts of the body. The blood distributes the fluid nourishment to the tissues of the body, and also serves to relieve these tissues of the poisonous carbonic acid gas, and to supply them with oxygen which it has absorbed while passing through the lungs. As the tissues of the body are used up in performing the work required of them, they are constantly being built up again by the nourishing materials which the blood conveys to them.

Combustion.—This process of building up the various parts of the body by the nutritious portions of the food, changed

to a fluid form by the organs of digestion, is followed by a consumption, or using-up, of the tissues when we use them in any way—in other words, when we *work*. This is called *combustion*, and means a *slow burning*, and it is accomplished by means of the oxygen which the blood carries to the tissues.

What Results from the Burning of Fuel—Work.—If we recall the resemblance of the human body to a stove, and the similarity of our food to the fuel, it will be instructive to ascertain what becomes of the fuel consumed in an ordinary fire. Take a locomotive, for example. Its fuel consists of *coal*, which, in *burning*, combines with the oxygen of the air, thus producing *combustion*. As a result of this combustion, *heat* is produced, which changes the water in the boiler into *steam*. The steam turns the wheels of the locomotive and furnishes the *power* which draws the cars, and enables us to travel many hundred miles a day.

Another Result of the Burning of Fuel—Refuse.—As has just been explained, one result of the burning of fuel in the locomotive is *steam*, this combustion taking place with the aid of the air. If there is no access of air there can be no combustion. Besides steam there is also produced *refuse*—ashes and smoke. These are of no value, and hence they are correctly called refuse, and allowed to escape, the smoke passing into the air and the ashes thrown away. What was wanted from the fuel was the *steam;* this does the *work*, whether it moves a locomotive or a steamboat, or lifts an elevator, or pumps up water; and all these are merely examples of different kinds of *work*. *Fuel*, then, *consumed* with the aid of the *oxygen of the air*, has resulted in *work*, which is of the greatest value to us; and in *smoke and ashes*, which are *refuse*, and which we throw away.

What Results from the Combustion of Our Food.—If now we inquire what becomes of the food which is consumed by our tissues, both that which we take in by the stomach, and the oxygen which the blood takes from the air,

we find that the same things are produced, namely, *heat* and *work*, which are of value to us, and *refuse materials*, which are of no use to us, and which are removed from the body. It has already been explained how the food is changed and then carried to the tissues by the blood, and also how the oxygen of the air is carried to the tissues. Both of these are fuel, and they unite with the tissues; the oxygen unites with the tissues and consumes them, and then the new food builds them up again. It may be asked, Why must the tissues constantly be used up and then restored? The answer is, Because we are constantly doing *work* and require *heat;* and to get these, the tissues must be consumed in our body, just as wood and coal are in the locomotive.

Casting off the Refuse Materials from the Body.—The refuse materials, which are no longer of any use, and which would be harmful if retained in the body, may be compared to the smoke and the ashes which escape from the locomotive. The organs which serve to remove them from the body are the *skin*, the *lungs*, the *kidneys*, and the *intestines*. The skin removes certain poisonous gases, and also certain other materials in the perspiration—hence the necessity of keeping the pores open. The lungs, as has just been explained, remove carbonic acid gas and other poisonous gases in the expired air. The kidneys remove impurities in liquid form. The intestines remove the solid refuse.

Food and Oxygen Produce Heat and Work.—It does not require much study to appreciate how much work the body is constantly doing. Even when asleep the body is doing work. The heart is working faithfully, beating to supply all parts of the body with life's fluid, the blood; the chest is rising and falling and the lungs expanding to take in air; and there are many other examples of work, of constant work. When a man is deep in thought, it might be considered that he is idle and resting, but this would be incorrect. Such a man is working very hard with his brain, and such work is

as tiring as working with the hands. Other examples of work we see around us every day—the men digging, paving the streets, and building the houses. When hard work is required more food is necessary than when persons are idle.

Warm-blooded and Cold-blooded Animals.—If you touch a stone in the street it will be cold in winter, but warm in summer if the sun has been shining upon it. But though it may feel warm, it has no heat of its own, and is simply warm or cold according as the air around it is warm or cold. If you put it in a fire it will become hot, but if taken out again it becomes as cold as the bodies around it. This is the case with all bodies which have no life. But with animals it is different; they have heat of their own, and it does not matter whether the air around them is cold or warm, their blood will be about the same. Animals can be divided into two classes. One class, the fishes, have cold blood; you will remember how cold and clammy a fish feels. Fishes belong to the *cold-blooded* animals. Most animals, however, have warm blood, and hence are called *warm-blooded* animals. Most of the animals we see are of this class. Birds have especially warm blood.

Heat of the Human Body.—The heat of the human body is about 98 degrees as measured with the *thermometer*. All of you have probably seen a thermometer. It is a long, hollow tube of glass, containing a silvery fluid called quicksilver. Heat makes the quicksilver rise, and the more heat the higher it rises; so that we tell how hot anything is by the height to which the fluid in the thermometer rises, there being numbers attached to the frame of the instrument to express the heat. Ninety-eight degrees expresses the heat of our blood, and hence this is called *blood-heat*. On a very warm day in summer you may read about the thermometer having risen to blood-heat; this means 98 degrees.

The skin is never so warm as the blood. In winter the skin, especially of the hands, may be quite cold, and yet the

blood-heat remains the same. On the other hand, our skin may be very warm in summer, and still the heat of the blood does not rise. So that the blood and the interior of the body have the same heat in summer as in winter, namely, 98 degrees.

Heat of the Body in Sickness.—When sick with fever, the blood becomes hotter; and if this increase of heat is more than a few degrees, it is very dangerous.

Regulation of the Body Heat.—In summer, when it is warm, there does not need to be so much heat produced in the body, and we naturally take less food, and wear lighter clothing, and do not work so hard as in the cold months. In winter, on account of the coldness in the air, we must have an extra supply of body heat, which we produce by eating more, by wearing heavier clothing, and by doing more work. In winter we should take more exercise than at any other time of the year. Nature usually gives us a better appetite in winter than in summer, and we usually eat more meat than when the weather is warm.

There is another way in which we increase the warmth of the body in winter, and that is by wearing warmer clothing. But it has just been stated that clothes do not produce heat; then why do we wear thicker and warmer clothes in winter than in summer? This statement is true, *clothes do not produce heat*, but they prevent the warmth from leaving the body too quickly. In winter the air is very cold, and the heat of the body would pass into the air very soon, to prevent which we put on warm clothing.

Warm Clothing.—*Woollen* clothing is the warmest. In winter it is well to wear flannel next to the skin. In summer linen clothing is the coolest. Black clothes are warmer than white ones because they absorb more external heat. This can easily be shown in the following way: If you take two pieces of cloth of the same kind and size, and place them on the snow, that under the black cloth will be melted before that

under the white one. This is the reason for wearing dark clothing in winter and light colors in summer.

How to Keep Warm in Winter.—In winter we depend upon *exercise, additional food,* and *warmer clothing* to keep us warm. And all three of these must be combined if we want to feel comfortable. You have seen car-drivers slapping their arms about on a cold day. This gives them exercise and makes them warm; it makes the warm blood circulate faster, and this brings heat to the tissues. If you stand still on a wintry day the feet soon become cold. This is very unhealthy, and is a sign that you should exercise in order to get more blood back into the feet. If we go out on a cold day before breakfast we feel very chilly; and everyone knows how much better he is able to stand the cold after having had a warm meal.

How to Keep Cool in Summer.—In summer we should eat *less meat* and *less food* than in winter. Usually our appetite is not so good in summer as it is in winter, and naturally, therefore, we take less food, and we should wear *light clothing.* Everything we do during the warm parts of the summer days we should do *slowly* and should *not hurry.* We should not walk much in the sun without being shaded.

How the Body is Kept Cool in Summer.—It would seem difficult to prevent the body from being overheated in summer when the air around us is so warm; and you might wonder, too, why it is that the blood of a locomotive engineer, or of a cook, who is in front of a hot fire all day long, is no warmer than that of persons who can keep cool. There are two ways in which the bodily heat is prevented from rising above 98 degrees when persons must be near furnaces and fires or are otherwise exposed to the heat.

Both methods depend upon the fact that *whenever moisture or water leaves any surface it makes that surface cold;* that is, it takes some of the heat of that surface with it. In India, the drinking-water is cooled by placing it in porous clay

vessels which allow a little of the water to soak through, after which it passes off into the air and thus makes the rest of the water cool. If you wet your hand and then hold it in the air, it feels cold, because the water in passing into the air takes some of the heat of the hand with it.

In this way our blood does not get any warmer in summer than in winter. For in summer more moisture leaves the body than in winter. Moisture leaves the body in two ways: By the *lungs* and by the *skin*. We breathe more rapidly in summer than in winter, especially if it is very warm, and in this way, more moisture is given off to the air from the blood passing through the lungs. Then again, the expired air contains more moisture in summer.

Perspiration.—The moisture which passes off by the skin is called *perspiration*. This is taking place constantly through the pores, but in summer so much passes off that it collects in drops and is then called *visible* or *sensible* perspiration.

Ice-water in Summer.—There is no objection to ice-water in summer if you do not drink too much, and if you take but a little at a time. Some people get into the habit of drinking ice-water constantly. This is very unhealthy and will make them suffer. But if it be remembered to drink it slowly and only a little at a time, it will not usually do any harm.

Sunstroke.—When a person has been in the sun a long time, the heat of the blood may become so great, or the effect of this heat upon the nerves so serious, that it makes him dangerously sick; this is called *sunstroke*. It is a very dangerous condition. If you have to walk much in the sun, you should stop and go into the shade and rest as soon as you feel the least faint or dizzy.

Effects of Cold.—If we are in the cold a long time, it sometimes happens that we *freeze the nose, ears, toes, or fingers*. When this occurs, the frozen part of the body becomes pale or purple. At first it becomes painful, but when really frozen it has no feeling at all. The reason these parts of the body

freeze is because the blood does not flow in them as it should; there is too little blood in them, and so there is too little heat to keep off the cold. When the ears or the nose begin to smart they are beginning to feel the effects of the cold, and we should rub them so as to bring the blood back. When we are very cold and have frozen a part of the body, we should not go near the fire at once; the change of temperature would be too sudden and the frozen part might die. We should give the frozen part a thorough rubbing.

Effect of Alcohol in Bodily Heat.—It is a great mistake to suppose that alcoholic drinks warm the body. They flush the skin and make it *feel* warm, but they in reality only expose the warm blood more completely to the chilling effects of the air. It is true that a man who has been drinking does not feel cold, but that is because the nerves of his body, by which he perceives heat and cold, are slightly paralyzed, and do not carry true sensations; therefore he is all the while being chilled, and sometimes he may be frozen without knowing it, whereas if he had not been deceived by his false sensations he would have put on warmer clothing or exercised or increased his bodily heat in some natural way.

The thermometer shows what a perceptible loss there is in bodily heat after taking strong drink. Some drunken men have been known to have a temperature two or three degrees below normal.

It is said that in the Russian army when a long cold march is to be made, a corporal makes the rounds to smell the breath of all the men, and if any are found who have been taking alcoholic drinks they are sent back as unfit to stand the cold.

The effect of liquor was shown very well in Napoleon's campaign in Russia; of those soldiers who succumbed to the severe cold and exposure, by far the majority were addicted to the use of alcoholic drinks.

The following incident shows that the body loses its heat in direct proportion to the amount of alcohol drunk.

A party of men crossing a western prairie, who were obliged to spend a very bitter night on the ground, with no shelter, were advised by their leader not to drink any alcohol. Three drank themselves drunk and were found frozen to death in the morning. Four, who became partly intoxicated, were badly frozen and died of the effects later. Others who drank a little were frost-bitten in their toes and fingers, and the only ones who escaped freezing were the leader and two others, who did not touch a drop.

SYNOPSIS.

Combustion—The slow consumption of the tissues:

a. Requires food and oxygen.

b. Produces:

1. Life.
2. Growth.
3. Work and heat.

Refuse of the Body:

a. Gaseous, given off by:

1. Lungs—expiration.
2. Skin.

b. Liquid, given off by kidneys.

c. Solid, given off by intestines.

Heat of Animals:

a. Warm-blooded animals.

b. Cold-blooded animals.

Heat of the Human Body:

1. About 98° in health in the interior.
2. Colder on the surface of the skin, depending upon the warmth of the air. May be slightly warmer in summer.
3. Higher in sickness (fever).
4. Regulated by:

(1.) Amount and kind of food.

(2.) Amount and kind of clothing.

(3.) Amount of exercise.

(4.) Perspiration.

To Keep Warm in Winter:

1. Much clothing, especially woollen; flannel next to skin.
2. Much food, especially meat.
3. Much exercise.

To Keep Cool in Summer:

1. Light clothing, especially linen.
2. Less food, and less meat.
3. Less exercise.

The Control of Bodily Heat in Summer—By increased escape of moisture by lungs and by skin.

Undesirable Effects of Heat and Cold:

1. Sunstroke.
2. Freezing parts.
3. Bad effects of too much ice-water.

Effect of alcohol on bodily heat. Reduces temperature. In cold climates renders one liable to freeze.

QUESTIONS.

1. What effect has our clothing upon the body heat? 2. In what way can the body be compared to a stove? 3. What corresponds to the fuel of the stove? 4. What do we call the slow burning which takes place in the body? 5. How does fuel do work in the locomotive? 6. What results from the fuel in a locomotive besides the steam which does the work? 7. What results from the combustion of our food? 8. What does the oxygen of the air do? 9. Why are the tissues constantly used up and then restored? 10. What gases are given off from the body? 11. What is the object of taking food into our stomach, and oxygen from the air into our blood? 12. What do these produce? 13. Is the body ever idle? 14. What work does it do even when we are asleep? 15. Is the body doing any work when we think? 16. Can a hard-working man get along on as little food as one who is idle? 17. Do all animals have the same warmth of the blood? 18. What is meant by a cold-blooded animal? 19. Give an example. 20. What is meant by a warm-blooded animal? 21. Give an example. 22. Have bodies without any life in them any heat of their own? 23. What is the heat of the human body? 24. What is a thermometer? 25. Is our skin warmer or cooler than the rest of our body? 26. What change is there in the heat of the body when we have fever? 27. What do

we do in summer so that less bodily heat shall be produced? 28. Do we need more heat or less heat in winter than in summer? 29. How do we produce more heat in winter? 30. Do clothes *produce* heat? 31. What do they do to the heat? 32. What is the warmest kind of clothing? 33. What is the coolest kind of clothing? 34. What color of cloth is the warmer, black or white? 35. How can you show this? 36. What should we do to keep warm in winter? 37. What should we do to keep cool in summer? 38. How is the body kept cool in summer? 39. Does the blood become warmer if we stand in front of a fire all day? 40. What effect is produced when moisture passes into the air? 41. How can you show this effect by an example? 42. In what ways does moisture leave the body? 43. What is perspiration? 44. How does perspiration keep the heat of the body from rising? 45. How can you take ice-water in summer without harming you? 46. What is sunstroke? 47. What should you do to avoid being sunstruck? 48. What are the effects of great cold? 49. What parts of the body are we most apt to freeze? 50. In what way may certain parts of the body freeze? 51. How does the nose or ear feel when it is freezing? 52. How do they feel when they are frozen? 53. Should we go near the fire immediately when we have frozen a part of the body? 54. What should we do? 55. What effect does alcohol have on the heat of the body? 56. What danger do men in cold climates run, if they drink alcohol?

CHAPTER XII

TOBACCO AND OTHER NARCOTICS.

Substances which *benumb the system* and produce sleep are called *narcotics.* Insensibility and death may result from their effects if enough is taken. Narcotics benumb the brain, and thus produce an artificial sleep, which usually lacks the refreshing qualities of natural sleep, being often followed by a stupid condition and by headache. Alcohol is a narcotic; this is seen in a very pronounced manner in the heavy sleep which occurs in drunkenness. In some persons, even a small amount of alcoholic drink will cause drowsiness; this effect is noticed especially after drinking malt liquors.

TOBACCO.

Tobacco is a narcotic. It has a benumbing effect upon the brain and nerves, though it does not always produce sleep.

History of Tobacco.—The custom of smoking and chewing tobacco had been prevalent among the Indians for a long time when America was discovered. In 1560 Nicot, the French Ambassador, brought some of it to France. It was introduced into England in 1586 by Sir Walter Raleigh; before the end of the century its use had spread over nearly the whole world.

Cultivation and Preparation of Tobacco.—The Cuban leaf is the most highly prized, but tobacco grows anywhere and everywhere. It is cultivated in every State of the Union, though some States grow much more than others. Virginia produces over eighty million pounds, and Kentucky

over one hundred and seventy million pounds a year. The plant reaches the height of several feet; it has large, spreading, pale-green leaves.

In *preparing tobacco for use* the plant is cut near the ground at the end of summer, and the leaves are *dried* on the stems by hanging them in barns. Then they are afterward *stripped* from the stems, moistened, and tied into bundles. These are piled up for a number of weeks, during which a sort of *fermentation* goes on; this brings out a dark brown color and develops an *aroma.* Tobacco is then rolled to form *cigars,* or cut into delicate shreds which are made into small cylinders by means of paper or tobacco wrappers to make *cigarettes,* or chopped more or less fine for use in *pipes,* or ground into a fine powder for *snuff.* When used for *chewing* it is mixed with sugar or molasses, licorice, and other ingredients, and packed in paper or pressed into hard pieces.

Composition of Tobacco.—Its important constituent is a very *poisonous liquid,* which readily escapes into the air and which at first is colorless, but soon turns brown; this poison is called *nicotine,* and tobacco contains from two to nine per cent. The odor and aroma of tobacco seems to depend upon an oily or fatty substance, called *oil of tobacco.*

Effects of Tobacco upon the System.—The effects of tobacco upon the system are influenced by *habit* and by the *peculiarities* of individuals. There is a great difference between the effects produced at first, and those which follow after the system has become accustomed to it. When *first used,* and in those unaccustomed to it, tobacco produces dizziness, headache, perspiration, sickness at the stomach, vomiting, great weakness, and trembling.

After a time the system usually becomes *accustomed* to its use, and a *tolerance* is established. It then acts as a *mild narcotic,* leaving a *sense of repose,* and having a *quieting influence upon the body and mind* as long as the effect lasts, but as it begins to wear off a sense of uneasiness, irritability, and

nervousness follows, which calls for a repetition of the indulgence. But this soothing effect is not produced in every user of tobacco. There are many persons who never experience it; and quite a large number are made *uncomfortable* by tobacco in any form, even in the smallest quantities, and never succeed in becoming accustomed to it, or in deriving any comfort or satisfaction from its use.

Tobacco as a Medicine.—Tobacco is now *no longer used as a medicine.* Formerly a tobacco poultice was sometimes applied to bruised or inflamed parts; but this use proved objectionable because the poisonous part of the drug was taken up into the system through the skin, and often gave rise to serious symptoms.

The Tobacco Habit.—The fondness for tobacco is an *acquired habit.* At first it is probably used merely from a desire to imitate; then it becomes a habit, and soon causes a craving which is satisfied only by larger and larger quantities. This habit does not, however, become as firmly rooted as the alcohol habit; and the evils resulting from the use of tobacco are not so apparent and pronounced as those caused by alcohol.

Injurious Effects of Tobacco on the Adult.—Quite a number of adults suffer from symptoms which are directly due to the effects of tobacco, and are consequently evidences of *tobacco poisoning.* In many cases such symptoms are slight, but in many others they are serious enough to demand the discontinuance of the use of tobacco in any form. The poisonous effects of tobacco may show themselves in the throat, the lungs, the heart, the eye, and the nerves, in loss of appetite and indigestion; they comprise a group of symptoms of very common occurrence.

In the case of the young it is unquestionably a poison which causes decided injury.

Smoker's Sore Throat.—The irritating effect of tobacco-smoke often causes a reddened, raw condition of the

throat, giving rise to a feeling of dryness or of scratching, and known as *smoker's sore throat.* This irritation may extend into the bronchial tubes and provoke a chronic *cough.*

The appetite may suffer and attacks of *indigestion* may occur ; a form of dyspepsia may be set up. Periods of *dizziness* and of *faintness* occur from time to time in those who are unfavorably affected by the use of tobacco.

Tobacco Heart.—Numbers of smokers are compelled to give up the habit on account of its producing what is called "*tobacco heart*"; this is a nervous derangement of the action of the heart, showing itself in *fluttering* and *palpitation,* with too *rapid* and *irregular* action.

Tobacco Blindness.—As a result of tobacco poisoning, the optic nerve is sometimes affected, and a form of *blindness* ensues. This gives rise to the same symptoms and is caused by the same wasting of the nerve of sight as the blindness from the alcohol habit, which has already been described.

Tobacco Nervousness.—*Nervousness* and *trembling,* frequently quite marked and noticeable, are often the consequences of smoking.

Injurious Effects of Tobacco on the Young.—Many public schools, as well as military and naval academies, forbid their pupils to use tobacco, for examinations of many boys who have been accustomed to the use of it show that, almost without exception, they have trouble with the heart or digestion, from which they recover if the practice is given up in time ; but which would settle into chronic disease if they persisted in its use. Even men who have formed the habit of smoking, and who cannot or will not break themselves of it, are unanimous in stamping it as *one of the most poisonous and injurious practices, when indulged in by young and growing persons.*

It checks their growth, weakens the system, and impairs both muscular and mental activity. Of this there can be *no* doubt.

Some of the States have very wisely passed laws forbidding the sale of tobacco to young people.

The *Medical Record* of New York, the most prominent medical journal in the United States, says: "The evils of tobacco are intensified a hundred-fold on the young. Here it is *unqualifiedly and uniformly injurious.* It stunts the growth, poisons the heart, impairs the mental powers, and cripples the individual in every way. Not that it does this to every youth, but it may be safely asserted that no boy of twelve or fourteen can begin the practice of smoking without becoming physically or mentally injured by the time he is twenty-one. Sewer-gas is bad enough, but a boy had better learn his Latin over a man-trap than get the habit of smoking cigarettes."

Influence of Tobacco upon Muscular Strength and the Power of Endurance.—What has been said of the necessity of avoiding alcohol during the process of training applies with equal force to tobacco. No athlete is allowed to use tobacco in any form during the preparation for running, jumping, rowing, or other similar contests, since it interferes with the fullest development of muscular strength and the power of endurance.

Cigarette Smoking.—This is probably the *most injurious* form of using tobacco. Cigarettes are usually made of the very poorest stuff. Being common and cheap, they are brought within the reach of boys, and in this way tobacco tempts and injures the young in the most insidious manner. While the smoker of a cigar or pipe simply draws the smoke into the mouth and then expels it, the cigarette smoker usually *inhales* it—that is, he either voluntarily or involuntarily draws it into his lungs. This practice is not only irritating to the lungs, but it enables the air-spaces to absorb much more of the poisonous nicotine than when the smoke is simply drawn into the mouth and then puffed out. The paper with which cigarettes are made is another objec-

tionable feature, its smoke being *harsh, irritating, and poisonous.*

Other Objections to the Tobacco Habit.—The use of snuff is a *filthy* habit which is not as prevalent now as it used to be; it is apt to injure the sense of smell and to keep the nose and throat in an irritable and unhealthy condition. Chewing tobacco is a *disgusting habit* which makes the breath foul, discolors the teeth, and is accompanied by the dirty practice of spitting.

Even under the most favorable circumstances a number of objections, based upon abuse of the sense of cleanliness, can be urged against smoking. The smell of tobacco-smoke becomes stale and clings to the hair and the clothing. The teeth, and frequently the fingers, become discolored. The breath cannot be sweet, and the atmosphere of our houses is more or less vitiated. To many persons the smoke of tobacco is *offensive,* and some are even made sick by it; smokers are very apt to forget this and their good manners, and to subject such persons to great annoyance.

Smoking is an Expensive Habit.—Smoking is a very *expensive* habit. It is estimated that over *six hundred million dollars* are annually expended for tobacco in the United States; this is three-fifths of what drink costs, and twice as much as is spent for meat.

OPIUM AND MORPHINE.

Opium.—Opium is the dried juice of the unripe fruit of the *poppy-plant,* which is cultivated in many parts of Asia and especially in India. To obtain it the unripe capsule or seed vessel is cut into, so as to allow the milky juice to ooze out; the next morning this is scraped off, placed in earthen vessels to harden by evaporation, and then pressed into irregular globular masses, known as *opium.*

Physical Properties of Opium and Morphine.—Opium occurs either in the form of dark-brown, sticky masses, or as a brown powder. It has a peculiar smell. Its most important active principle is *morphine*, which is extracted by means of water, and forms white crystals. Morphine produces the *same effects* as opium; it is, however, about ten times as strong.

Fig. 76.—The Opium Plant.

Opiates.—Any medicine which contains opium or some preparation of opium is known as an *opiate*. When the soluble parts of opium are dissolved in alcohol and water, *laudanum* is formed; this is its most common fluid preparation. Opium mixed with ipecac and a diluting powder constitutes

Dover's powder. Paregoric, another fluid preparation, contains, besides opium, camphor, anise, and other ingredients. It is a very common method of employing an opiate, and is very often carelessly given to children.

Effects of Opium and Morphine.—Opium is a *powerful narcotic.* In the hands of physicians of skill it is one of the most *useful* drugs which we possess. Whatever is true of opium is also true of morphine, which is a concentrated equivalent of opium producing the same effect with about one-tenth the dose. Opium and morphine are exceedingly useful in *relieving pain* and *restlessness,* and in *promoting sleep;* they quiet the system and control spasms and convulsions; there is scarcely any part of the body which cannot be favorably acted upon in sickness by these agents, when properly and carefully prescribed by a competent physician.

Opium and Morphine Poisoning.—When an overdose is taken, however, they act as *powerful narcotic poisons.* A great many deaths result every year from poisoning by opium and morphine, taken intentionally or by mistake, probably a greater number than from any other poison. Infants and young children are much more easily poisoned than older beings. Some persons are peculiarly affected by opium and morphine, so that what is a small dose for one may prove to be a large dose for another; hence, even physicians have to be *extremely careful in prescribing* this very useful but very powerful drug.

The Opium or Morphine Habit.—Everyone has probably heard of the *opium habit,* or, what is the same thing, the *morphine habit.* It is a habit people get into of taking these drugs whether they need them or not. Morphine and opium take away pain and make people sleep when they are sick and restless; in such cases they do a great deal of good. But persons who have the morphine or opium habit do not take the drug for this purpose, but because they think it makes them feel good for the time being, and makes them forget any cares they may have. After the effects pass off, they feel *miserable.*

The stomach is upset, they are tired and nervous, have a very bad headache, and often feel like vomiting. They feel so bad that they take more and more, until finally they keep under the effects of it all the time.

In China, this habit is very prevalent, and it is estimated that over three million Chinese have the opium habit. The drug is imported from India and furnishes a great source of revenue to the English. In this country, the habit is, unfortunately, *greatly on the increase;* half a million persons in the United States have the opium or morphine habit, notwithstanding the fact that it is *forbidden by law*, and that the sale of opium or morphine is not legal except when called for by a physician's prescription.

The Pangs of the Opium and the Morphine Habit.—While under the influence of opium or morphine, the victim is in a sort of dreamy, drowsy condition, forgetful of all surroundings. As soon as the effects of the drug wear off, the wretched being is left in a *frightful condition.* He is entirely *demoralized;* he suffers from severe headaches and neuralgias; there is weakness, irritability, and restlessness; he is troubled and frightened and has a feeling of *intense horror.* The pangs of this period of awakening are said to cause indescribable suffering, and craving for more opium and morphine becomes *perfect torture.* He cannot rest until he has obtained another dose. He will do anything—lie, cheat, or steal—to satisfy this longing by securing more opium or morphine. Promises to reform are broken, and the firmest resolves count for nothing. The wretched prisoner of this habit has *lost all power over himself* and all controlling influence upon his moral sense. He is rightfully called an "*opium fiend*" or a "*morphine fiend.*" He knows and appreciates his calamity but cannot change it. The habit is one which is much more difficult to break up than is either alcohol or tobacco.

Results of the Opium and the Morphine Habit.—The effects of the opium and the morphine habit upon health

early show themselves. The poor wretch soon becomes nervous; he cannot sleep at night; he has no appetite; if he takes any food he cannot digest and often vomits it; he becomes thin and has a yellow complexion; his mind changes and he loses his memory; he has no longer the power to do right, and he is known to tell lies without hesitation, to cheat, and to steal, in order to get some of the drug.

The quantity of the drug which it is necessary to take to produce the desired effect constantly becomes greater; many of these unfortunates take at a single dose an amount which would be sufficient to kill twenty, or even fifty persons, who are unaccustomed to it.

CHLORAL.

Chloral, or *chloral hydrate*, is a substance prepared by the action of chlorine on alcohol, for use in medicine. Its physiological action, when applied directly to any part, is that of an irritant; when absorbed into the system, that of a narcotic. It produces a state resembling sleep, owing probably to its action on the cerebrum. The sleep induced by chloral may pass off like ordinary slumber, or may deepen into a fatal coma, according to the amount taken.

The Chloral Habit.—People sometimes get into the *habit* of taking this medicine regularly for its peculiar effects. It may have been prescribed originally by the family physician who intended it only for temporary use. But tempted by its soothing effect, some persons continue to use it, and to get into the habit of taking it regularly to relieve pain or to produce sleep, until they cannot sleep without it. They have then acquired the *chloral habit.* Though not as prevalent as the use of morphine or opium, it is nevertheless a *dangerous habit.*

Like alcohol and narcotics in general, the dose necessary to produce the desired result constantly becomes larger and larger, and the *longing* for the drug steadily increases. Many persons have acquired the habit in trying to relieve the

depressing effects of the *alcohol habit*, and in such cases they have usually merely succeeded in becoming the victims of an additional curse.

Effects of the Chloral Habit.—In a very short time, the *injurious effects* of this drug upon the system show themselves. The victim becomes nervous, weak, and very much emaciated; the skin is pale and yellow, he loses his appetite and acquires a dislike for food; he suffers from indigestion. Finally he becomes a complete *physical, mental, and moral wreck*, perhaps dying in a hospital from weakness, or ending his days in an insane asylum. Very often, also, he takes too much of the drug and this leads to a fatal end.

ABSINTHE.

Absinthe is a strong *alcoholic drink* which is *flavored with oil of wormwood.* Its effects correspond to those of other alcoholic liquors, but in addition the *wormwood* produces very decided and *poisonous* symptoms showing themselves especially upon the *nervous system.* The habit of consuming large quantities of absinthe is prevalent in France, but of late years this *dangerous habit* has travelled and has gathered in many persons in England and America, and it seems to be on the increase in this country. In addition to the effects of the alcohol, absinthe produces a sort of *unconsciousness or dreamy state.* The effects of the absinthe habit are very pronounced and lead to very *serious injury.* The victim loses all desire for food and suffers from *dyspepsia;* the tongue and mouth become dry and the throat irritable; *spasms* of various muscles occur, and if still persisted in, the habit causes *convulsions*, often leading to paralysis and death.

HASHISH.

Hashish, an extract derived from Indian hemp, is used as a *narcotic* by the natives of India. It produces a drowsy condition in which objects are seen, but seem a great distance

off, and passed events are recollected as though they had occurred at some very remote period. Though still used by many natives of India, the habit does not seem to have had any charm for others. It is rarely met with in this country.

CHLOROFORM.

Chloroform is a remedy of *incalculable benefit.* It is a colorless fluid having a pleasant odor. It is *inhaled* like ether for the purpose of producing *unconsciousness,* so that operations upon the body can be performed without causing any pain. It is also used, both externally and internally, for the *relief of pain and spasm.* Occasionally, we find individuals who have formed the *habit of inhaling chloroform* whenever they have the slightest pain or for the purpose of putting them to sleep. This practice is extremely *dangerous;* many of such unfortunate persons lose their lives from an overdose. *Under no circumstances* can chloroform be safely used, unless given by a physician.

SYNOPSIS.

Narcotics—Benumb the system; relieve pain; produce sleep; powerful and dangerous. Most common narcotics are opium, morphine, and chloral; also alcohol in large amount. Tobacco is a mild narcotic.

Tobacco—The dried leaves of the tobacco-plant.

1. Used by American Indians for long time previous to landing of Columbus.
2. Introduced into France in 1560; into England, by Sir Walter Raleigh, in 1586.
3. Cultivated in the United States and in every other part of the world.
4. The leaf must be prepared for use by drying, moistening, and fermenting, to bring out color and aroma.
5. Used in smoking (cigars, cigarettes, pipe), chewing, and snuffing.
6. Contains a poisonous principle called nicotine, and another called oil of tobacco.

7. Effects upon the system:

1. When first used—Dizziness, headache, perspiration, sickness at stomach, vomiting, faintness, and trembling.

2. After a time tolerance is established.

3. Quieting effect and sense of repose in some persons.

4. On other persons, no effect, or disagreeable effect.

5. No longer used as a medicine.

6. Causes smokers' sore throat.

7. Appetite suffers, dyspepsia, indigestion.

8. Tobacco heart.

9. Tobacco blindness.

10. Tobacco nervousness.

11. When used by young and growing persons: Checks growth, weakens system, impairs muscular and mental activity.

12. Diminishes muscular strength and power of endurance.

8. Cigarette smoking especially injurious.

9. Smoking is an uncleanly habit; hair and clothes smell of stale smoke; breath offensive; teeth soiled; smoke is offensive to other persons.

10. Chewing and snuffing very filthy.

11. The use of tobacco is an expensive habit; over six hundred million dollars spent annually in the United States.

Opium and Morphine:

1. Opium is the dried juice of the unripe seed-vessel of the poppy-plant; comes from India and neighboring countries; occurs in brownish mass or powder; powerful narcotic poison.

2. Morphine is extracted from opium; occurs in small, white crystals; has same effects as opium; is about ten times as strong.

3. Opiates: Medicines which contain opium.

4. Preparations of opium: Laudanum, paregoric, Dover's powder.

5. Effects of opium and morphine: Relieve pain and restlessness; break spasms and convulsions; produce sleep.

6. Useful only when prescribed by a physician.

7. Persons often acquire the habit of taking opium or morphine; this habit is very injurious, and exceedingly difficult to break; the health suffers very much; the poor victims endure a miserable existence.

8. Opium and morphine poisoning; very dangerous; often fatal.

Chloral or Chloral Hydrate :

1. Occurs in white crystals, soluble in water.

2. Quiets the nerves, relieves restlessness, takes away pain, produces sleep.

3. Useful drug when prescribed by the physician.

4. The chloral habit, a dangerous habit to get into, of taking the drug to produce sleep; also to relieve the depressing effects of the alcohol habit.

5. Chloral habit causes nervousness, pale and yellow complexion, weakness, emaciation, indigestion, and ends in complete physical, mental, and moral wreck; insanity.

Absinthe—A strong alcoholic drink, flavored with oil of wormwood.

1. Effects : Those of alcohol, and in addition, poisonous effects of wormwood upon nervous system.

2. Absinthe habit prevalent in France, to less extent also in this country.

3. Produces sort of unconsciousness or dreamy state.

4. Absinthe habit results in serious injury to health, and may lead to convulsions, paralysis, and death.

Hashish—An extract derived from Indian hemp; used as narcotic by natives of India; not used in this country.

Chloroform—A fluid having pleasant odor; inhaled like ether to produce unconsciousness so that operations can be performed without causing pain; occasionally inhaled from habit to relieve pain or produce sleep; this practice very dangerous.

QUESTIONS.

1. What are narcotics? 2. Name the narcotics most frequently used? 3. What is the effect of an over-dose? 4. Is tobacco a narcotic? 5. When does alcohol act as a narcotic? 6. What is tobacco? 7. Where does it grow? 8. What is the origin of the name? 9. What is our earliest knowledge of tobacco? 10. When and by whom was it introduced into France? 11. Into England? 12. How is tobacco prepared? 13. In what different ways is it used? 14. What is the composition of tobacco? 15. What are the effects upon the system when first used? 16. Do these effects always continue? 17. What agreeable effects has tobacco upon some persons? 18. Does it have such agreeable effects upon all persons? 19. Is it used as a medicine? 20. How is the tobacco habit acquired? 21. Is it ever positively beneficial to adults? 22. Name some of the injurious effects upon the system? 23. What is smokers' sore throat? 24. How may the appetite and digestion suffer from tobacco? 25. What is tobacco heart? 26. What is tobacco blindness? 27. What is tobacco nervousness. 28. What are the effects of tobacco upon young and growing persons? 29. What effect has it upon the growth, strength, and muscular and mental activity of young people? 30. What influence has tobacco upon muscular strength and the power of endurance? 31. Why is cigarette smoking especially injurious? 32. What other objections are there to the tobacco habit? 33. Illustrate how expensive the tobacco habit is? 34. What is opium? 35. What is its appearance? 36. Where is it cultivated? 37. What is morphine? 38. From what is it derived? 39. What are opiates? 40. What is laudanum? 41. What is paregoric? 42. What is Dover's powder? 43. What are the effects of opium and morphine? 44. For what purposes are they valuable when prescribed by the physician? 45. What happens when an over-dose is taken? 46. What is the opium habit? 47. What is the morphine habit? 48. Is the opium habit common? 49. What effect has it? 50. Describe the horrors of this habit. 51. What is an "opium fiend?" 52. What are the results of this habit? 53. What is chloral or chloral hydrate? 54. For what is it prescribed by physicians? 55. What are its physical properties? 56. What effect has it upon the system? 57. What is the chloral

habit? 58. How is it acquired? 59. For what purpose do such persons use chloral? 60. What are the results of the chloral habit? 61. What is frequently the end of this habit? 62. What is absinthe? 63. What are its effects upon the system? 64. What is the absinthe habit? 65. Where does it exist principally? 66. What are the results of the absinthe habit? 67. What is hashish? 68. By whom is it used? 69. What are its effects? 70. What is chloroform? 71. What are its physical properties? 72. What are its uses? 73. What is the chloroform habit? 74. Why is it dangerous?

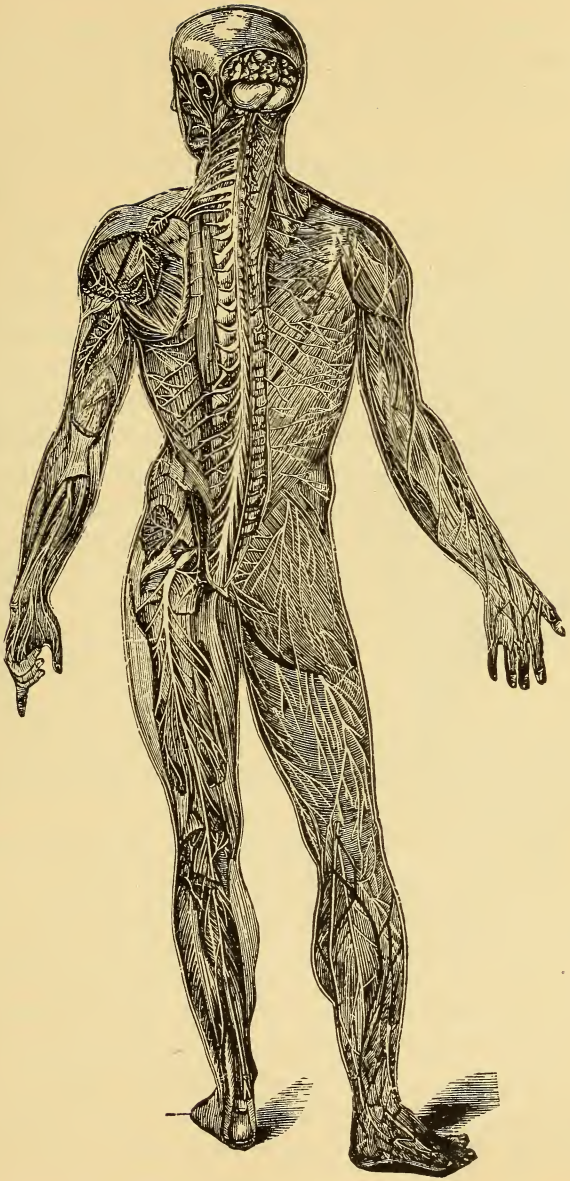


Fig. 77.—General View of the Nervous System in the Human Being.

CHAPTER XIII.

THE NERVOUS SYSTEM.

Thus far the bony framework of the body and the muscles which cover and move the skeleton have been spoken of. The food and drink which man should take and what becomes of this have been considered; also how this food is digested and taken up by the blood, forming new tissues. The heart and the blood-vessels which convey the blood to all parts of the body have been described. The lungs and breathing and the effects of pure and impure air, have been studied. Finally, the necessity of the body's having and keeping a certain warmth has been spoken of.

These functions are found in all animals, but they are not peculiar to animals for they also exist in plants. The word *function* was defined to be the *work* which any part of the body does. All these different kinds of work that we have been studying, and which are necessary for animal life, are also found in plants.

Similarity in the Structure of Plants and Animals.—The plant has a framework which corresponds to our skeleton, though of course it is not made of lime. This can often be seen in leaves that have been in water a long time; the soft parts have rotted away, leaving the stems and ribs of the leaf, as is shown in Fig. 78. In plants there is a soft, usually green matter to clothe this skeleton. Plants take in food and drink by their roots and by their leaves. They also breathe through pores in their leaves, and take in air and give it up as animals do. But from the air they take in the poisonous

gases and give up pure oxygen. This is just the reverse of what animals do. It may be well to explain what *pores* are. They are the very small openings in the skin or in the coverings of leaves; and are usually too small to be seen without a microscope.

Then again plants have *sap*, which serves as their blood. It is not of a red color as blood is, but like the blood in animals, it carries the nutritious juices to the different parts of the plant. There are tubes which carry the sap, just as blood-vessels do the blood. Finally, plants have a certain warmth of their own, just as animals have; not so great as in animals, but if many plants are placed in a closed room, the air in this room after a time becomes comparatively warm.

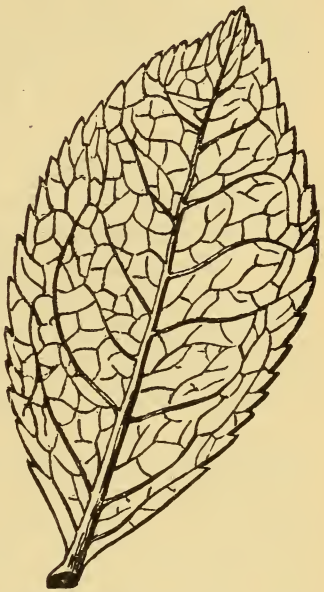


FIG. 78.—The Skeleton of a Leaf. After long-continued soaking in water, the soft part of the leaf has been removed, leaving the woody portion forming the framework, which gives the leaf its shape and strength.

Absence of Nervous System in Plants.—Thus it will be seen that plants have all the parts and the same functions that have been described in animals thus far. But now will be considered certain parts in animals which plants do not possess, the first and most important of which is *the Nervous System.* Let us first see what is meant by the word *system.* It is a *collection* of tissues of the same kind. So that nervous system is a collection of nerves, or in other words, all the nerves of the body taken together are called the *nervous system;* all the arteries taken together would be called the *arterial system.* All the muscles of the body are called the *muscular system.*

Most Perfect Nervous System in Man.—The nervous system is something *peculiar to animals* and does not exist in plants. In animals there is a great difference in regard to how perfect this nervous system is. The higher the form of the animal, the more perfect is its nervous system. Man being the highest form of animal, his nervous system is much more developed than in any other animal. In some of the lowest animals it is very imperfect indeed. In other functions, such as respiration, circulation, and digestion, there are many classes of animals which are the equals of man ; but in the development of his nervous system man stands far ahead of all others.

Function of the Nervous System.—The nervous system gives us *information of the condition of the body* and of *what is going on around us*, so that we can do what is best and avoid danger. It is also the work of the nervous system to *connect the different organs of the body* so that they will work in harmony. If it were not for the nervous system we should constantly be in danger of losing our lives. It enables us to feel, think, see, hear, etc., and in this way we avoid injury. When a large number of persons are working separately there must always be a head or chief to direct them. Imagine what disorder there would be in the class-room if every pupil did as he or she wished and there were no teacher. Think of an army of soldiers over which there was no general, and every soldier did as he wished ; how dreadful the confusion would be! In the same way there would be great disorder among the organs of our bodies if there was not something to connect them and to direct their work ; this is done through the nervous system.

Divisions of the Nervous System.—We can divide the nervous system into certain parts, and these parts are all connected. We separate them only for the purpose of study.

There is first the *brain*, the head or chief that superintends the entire work of the system, just as the superintendent of a railroad manages the running of all the trains. The brain

is placed in a rounded, bony box made by the bones of the skull, called the cranium.

Next there is the *spinal cord*, which is still very important, though not so important as the brain. It is a sort of assistant to the brain, relieving it of a good deal of work, and also doing some work which the brain does not do. The spinal cord runs in the canal or tunnel which is in the back part of the spinal vertebræ.

Finally, there are the *nerves*. These are sent out from the brain and from the spinal cord to different parts of the body; and they also run in the opposite direction—from the various parts of the body to the brain and spinal cord. They are the messengers, or the telegraph wires, so to speak, which carry the wishes of the brain to the different parts of the body; and they also carry messages from the different parts of the body to the brain. These different parts of the nervous system are illustrated in Figs. 77 and 83.

Examples of the Action of the Nervous System.—The uses of the nervous system can best be understood by a few examples. Suppose a man is walking along the street and is about to cross the car-track. His ear hears the jingle of the bells and by means of a nerve sends a message to the brain; the brain then sends an order along the nerves of the eyes to these organs to look in the direction in which the ear has heard the sound and to see whether a car is approaching. The eyes obey the orders of the brain and look and see the car very near, and also perceive that the person is in danger of being run over. They immediately send back word to the brain about this danger. Then the brain sends word to the muscles which move his legs; this message is also transmitted by nerves; it tells these muscles to act immediately. The result is that they obey; he quickens his steps and thus escapes the coming car.

Let us take another example. Suppose it is time for the noon recess; you have taken your breakfast early in the

morning and have had no food since. The stomach sends a message to the brain that it has been empty for some time; and the tissues also send messages by numerous nerves that they would like more nourishment since they have exhausted all that the blood had to give them. Upon receiving these messages, which, in short, mean that you are hungry, the brain gives out its orders. It directs the legs to carry you home as soon as school is dismissed; it directs them to take you to the dining-room and to seat you at the table; it directs the eyes to look at the food and see whether it is wholesome; it orders the hands to seize knife and fork and to convey food to the mouth; the jaws are directed to chew it, the throat to swallow it and the stomach to digest it. All this the brain does.

Rapidity of Action of the Nervous System.—It has taken a little while to describe these two examples of the manner in which the nervous system acts, but it must not be imagined from this that so much time is consumed. All these messages are sent back and forth with lightning-like rapidity, and it takes only a very small part of a second for a message to travel from the tip of the finger to the brain and back again.

THE BRAIN.

Coverings.—The brain is a large, rounded mass of soft nervous tissue which is contained in the oval box of *bones* formed by the skull. These flat bones which cover it protect it from injury. Besides these, it is covered on the inside of the skull by *three membranes* or sheets of tissue; and it is therefore very well protected.

Size and Weight of the Brain.—The brain is about *eight inches long.* If looked at from above (Fig. 79) it appears *hemispherical;* if viewed on its under surface (Fig. 80) it is *flat.* It weighs about *forty-seven ounces*—about three pounds on the average. The brain of a man is larger and weighs more than

that of a woman. It was formerly thought that highly educated persons had very heavy brains, but this is not so in every case. It is true in certain cases, however, for the brain of Daniel Webster weighed sixty-three ounces. On the other hand, the brain of Gambetta, who was one of the brightest statesmen

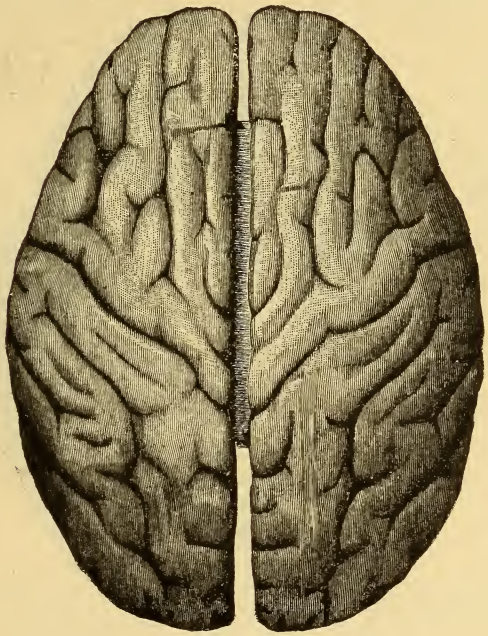


FIG. 79.—The Brain, Upper Surface.

France ever had, was said to weigh only thirty-five ounces. So that there are exceptions to this opinion. However, the brains of idiots are always small and light in weight. It will be explained further on in what way the brain of a very intelligent man differs from that of an idiot. The human brain is *heavier* than that of any other animal except the whale and the elephant.

Divisions of the Brain.—The brain is divided into three parts: First, the large, round mass called the *cerebrum*, which you see when you look at it from above, and which forms about seven-eighths of the entire brain (Figs. 79, 80, 81, and 83).

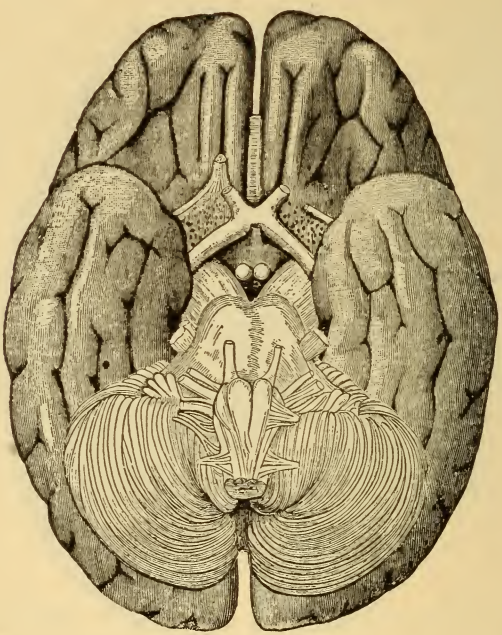


FIG. 80.—The Brain, Lower Surface.

Then beneath the cerebrum, at the back part, is the *cerebellum*, or little brain, a smaller portion, looking like two pouches, and forming only one-eighth of the entire brain (Figs. 80, 81, and 83).

Third, there is the portion, called the *medulla*, which is a sort of bridge between the brain and spinal cord (Figs. 81 and 83).

The Cerebrum.—As already stated, this is the main part of the brain. If you look at it from above you will see that it dips in along the centre, and you will find this cleft to be quite deep, separating the brain into two halves, called the *hemispheres*—a very appropriate name. The surface of the cerebrum is very uneven, due to the fact that it is covered by a great many winding elevations, between which the surface

FIG. 81.—The Brain, Looked at from the Side, Showing Very Nicely the Divisions of the Brain. The large mass above is the cerebrum; the smaller portion, below and behind, is the cerebellum. From the cerebrum above, a cylindrical portion is seen passing directly downward to the end of the illustration below; this is the medulla. The cerebellum is seen to be connected with its upper and back part.

dips in about an inch. In a person whose brain is very much developed and who is very bright, these elevations are very winding and complex, and between them the brain matter dips in very much; while in the lower animals the elevations are quite straight and simple, and there is very little dipping in between them.

Gray and White Parts of the Cerebrum.—On the outside the cerebrum is *gray*, but internally it is *white*. The

gray part consists of cells, that is, small bodies with a number of branches given off from them, which connect with the nerve-fibres. The interior of the cerebrum is white, and is formed by millions of nerve-fibres (Fig. 82).

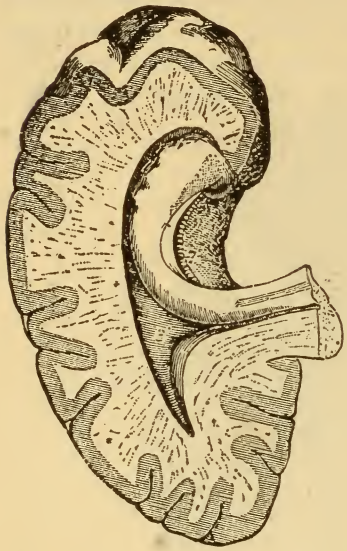


FIG. 82.—A Portion of the Cerebrum Cut Across, Showing the Gray Border on the Outside and the White Matter Within.

The Cerebellum.—This, like the cerebrum, is gray on the outside and white within. It is much smaller than the cerebrum, and is placed behind and below it, being covered up by it (Figs. 81 and 83).

The Medulla (Figs. 81 and 83) serves to connect the brain with the spinal cord. It is very important. There is one part of it to which any injury will produce instant death.

The Cranial Nerves.—What is a nerve? A nerve is a collection of nerve-fibres forming a small cord. These nerve-fibres are very small, and can be seen only with the microscope. But when a great many of them run alongside of each other they are joined into a bundle, and this we call a *nerve*. Some nerves are very large and others quite small. At the ends, where they pass to the tissues, they are very small indeed.

The *brain gives off twelve sets of nerves*, and these all pass to the tissues of the head and face. They are important, for among them are the nerves of smell, taste, sight, and hearing. There are small holes in the bones of the skull by which these nerves pass out. It has already been stated that the cranium is the bony box in which the brain is contained; hence these nerves are called *cranial*, because they come from

this bony box. They are arranged in pairs, one behind the other; on which account they are often called in numerical order, first, second, third, etc.

Functions of the Brain.—The brain is the *seat of the mind, of the will, of thought, of memory,* and of *intelligence.* It is through the brain that we are rendered superior to the lower animals. The lower animals accomplish different actions through what we call instinct, that is, without the action of the mind. But we can do many more things than they, and more difficult acts, because our brains are more developed.

Let us examine the work of the brain and see what it does for us: In the first place, it is where the *will* exists; it is where our desires come from. Then as to *memory,* it is the brain which enables us to *think* about things and to *remember* names, figures, faces, and all other things. Imagine how useful this is and how difficult it would be to get along without it! Think also of the wonderful action of the brain when it is possible to remember things all our lives!

The brain gives us *reason,* so that when we see a thing we know what it means and whether it is important or not. It gives us *judgment* which enables us to do the right thing in order to accomplish what we want.

Intelligence has its seat in the brain. This prevents us from being stupid; and enables us to understand things and to express ourselves just as we wish by language. It enables us to see the difference between right and wrong, so as to avoid the latter.

Training of the Brain.—Much of our memory and intelligence depends upon the way in which our brain is trained. If we use our brain a great deal, it will become better than if we allow it to remain idle. Many things which we study at school are taught us for the purpose of training the brain. We should remember that we cannot think of more than one thing at a time. When you study your lessons, you should not think of play; and when you play, you should enjoy yourself, and

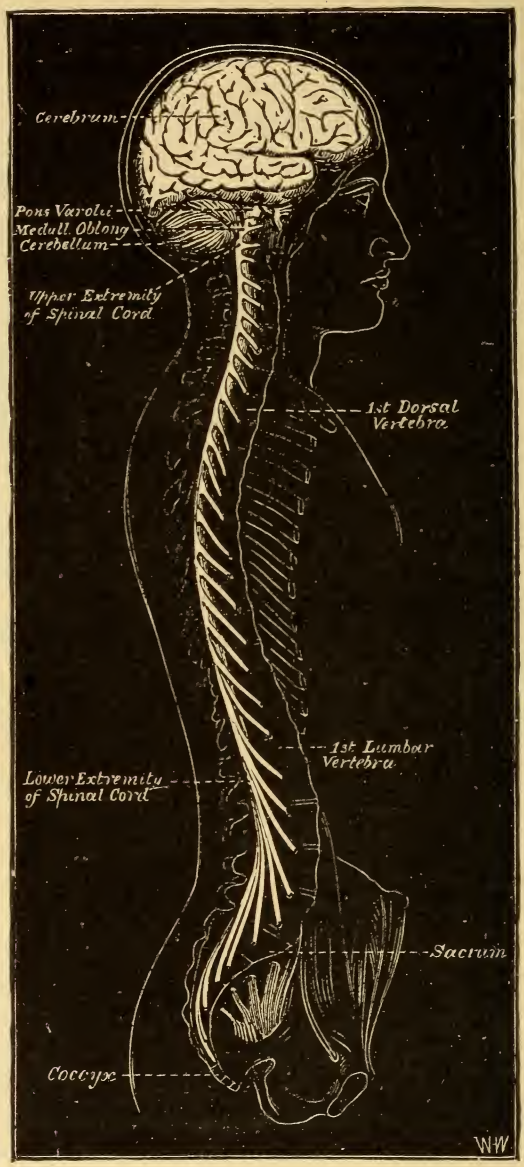


FIG. 83.—The Brain and Spinal Cord, with the Spinal Nerves Issuing from the Latter.

need not think of your studies. There is a time for play and a time for study.

THE SPINAL CORD.

The spinal cord is the soft bar of nerve-tissue which runs down from the brain through the canal of the backbone. In adults it is about as thick as the thumb. Besides being *protected by bone*, it has, like the brain, a covering of *three membranes*. While the spinal cord is not so important a part of the nervous system as the brain is, it is still very important, especially that part which runs through the neck. One sometimes hears of people falling down stairs and breaking their neck. What is meant by this is that this upper part of the spinal cord is broken across and death occurs immediately.

If the spinal cord be sliced crosswise it would be seen that although it is *white on the outside*, it is *gray on the inside*. This gray matter in the interior is arranged in a peculiar manner, resembling two crescents joined together, as is shown in Fig. 84. As in the brain, this gray part is formed of cells, while the white portion consists of nerve-fibres.

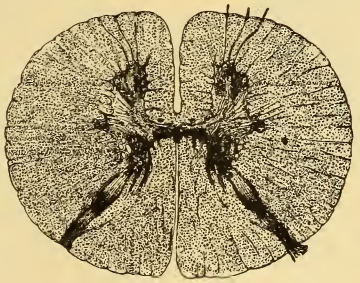


FIG. 84.—A Portion of the Spinal Cord Cut Across, Showing the Gray Crescents in the Interior, Surrounded by the White Nerve Material.

Spinal Nerves.—The nerves which leave the brain are called *cranial nerves;* and those which leave the spinal cord are called, in the same way, *spinal nerves*. There are *thirty-one pairs* of spinal nerves; and they are connected to the side of the spinal cord in a line. Each nerve when it leaves the spinal cord consists of two parts, one in front and the other behind; but these two portions soon unite to form a single nerve.

Kinds of Nerves.—There are two kinds of nerves—the nerves of *sensation* and the nerves of *motion*. The *nerves of sensation* are those which give feeling to different parts of the body and especially to the skin. When you cut or burn yourself it is a nerve of sensation which carries the message of pain to the brain. The *nerves of motion* are those nerves which go to the different muscles and cause them to act when the brain wishes it.

FIG. 85.—A Nerve, Very Highly Magnified, Showing How it is Made up of Numerous Nerve-fibres.

Functions of the Spinal Cord.—The spinal cord is a sort of *agent* or *assistant to the brain*, and it also serves to carry the large number of nerve-fibres which leave the brain, travel through the spinal cord and then to the limbs. But besides this, the spinal cord has a very important use. When the brain is engaged at something else, the spinal cord takes its place, and acts for it if any occasion arises.

Reflex Action.—This action without the knowledge of the brain is called *reflex action*, and it is the spinal cord which carries it out. Let us take a few examples of reflex action: Suppose you want to go to school in the morning. Your brain directs the muscles of your lower limbs to move in such a manner that you walk. But after you have started walking, you do not need to think about it; perhaps you reach school and have crossed many streets and have turned many corners without knowing it. It was the spinal cord which looked out for all this.

If a fly alights upon your face, you put up your hand to brush it off, without really thinking of it. This is another example.

During sleep, reflex action is shown very well. If you tickle the feet of anyone who is asleep, he will draw up his lower limbs so as to draw them away; all of which will be done

without his waking. It is the spinal cord which looks after this. In the same way, if you walk along, thinking of something else, and suddenly someone appears before you and makes a motion as though to strike you, you will draw up your arm to protect yourself before you can realize that anyone is there. If some one makes believe strike you in the face, you cannot help closing your eyes, and you cannot keep them open even if you want to. This is reflex action. It is also reflex action which explains how it is that a chicken can run around after its head is chopped off.

Sleep.—Sleep is the *natural rest of the brain.* Just as every other part of the body needs rest during each twenty-four hours, so does the brain. In fact, many other parts of the body can exist longer without rest than can the brain. We may rest any other part of the body without sleep ; but the only sign that the brain is resting completely, and is not active, is sleep.

The Amount of Sleep which is necessary varies with different people. Men who think a great deal require more than those who do bodily work. The *average sleep* necessary for a man is from *seven to eight hours.*

Children require more Sleep and should have *nine or ten hours,* for while the body is growing rapidly more rest is needed.

Uses of Sleep.—During sleep the brain and all other parts of the body rest and regain the strength which they have lost by the day's work.

Time for Sleep.—*Night* is the time for sleep. Persons who work at night and sleep by day are not usually quite so bright and healthy as those who sleep during the natural time. Young people who dance all night and then sleep by day to make up for it, soon look pale and tired out, and often weaken their bodies so much that they become sick. The proper time for children to go to bed is from eight to nine o'clock, and they should then rise at six or seven.

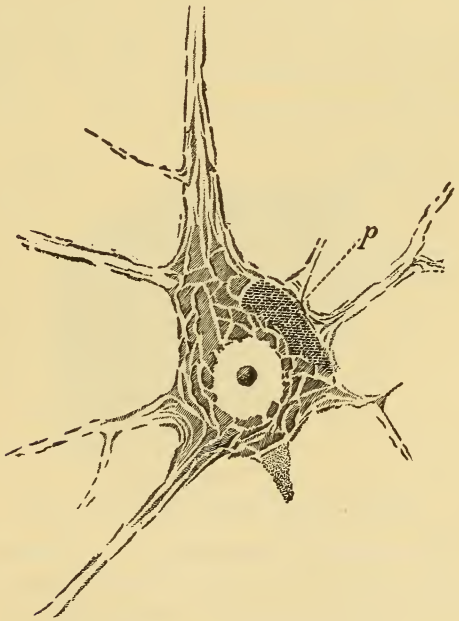
Nervousness.—We often hear people say they are nervous. By this they mean that their nervous system is out of order. They start at the least noise, and become cross and irritable, while the rest of the body suffers. Nervousness is often due to too little sleep or too much excitement. Very often, too, it is due to indigestion, or to coffee, tea, or tobacco, or alcoholic drinks. When we are nervous we are apt to do things in haste, and are apt to talk in a cross manner and to get angry easily.

Wakefulness.—When unable to sleep at night, we are said to suffer from *sleeplessness* or *wakefulness*. Lying awake at night when all is quiet and everyone else is asleep is very annoying. Not only does the body remain tired after the day's work, but the person becomes worried and cross because he cannot sleep. There are, of course, many causes of sleeplessness, but some of the most common are laziness, coffee, tea, and tobacco. It is quite natural for us to feel somewhat tired at night, and then we have no trouble in falling asleep; but if we are idle all day long, we do not feel tired, and on this account we may find it hard to fall asleep. Coffee, tea, and tobacco excite the nervous system, and on this account may prevent sleep.

Effects of Alcohol upon the Brain.—The brain is the organ that is most quickly affected by alcoholic drinks. People who take their first glass of beer or hard cider or whiskey say that it "goes to their head." They feel a sense of dizziness, and the floor seems to rise. They cannot put their feet down straight, and if they try to walk they are apt to fall. This is because the blood, as soon as the controlling nerves of the circulation are affected, rushes to the brain and spinal cord just as it does to the face, but whereas it only heats the face, it acts on the delicate cells of the brain and cord, and excites them. In many people this gives a feeling of exhilaration. They say they feel toned up. But the brain is so delicately constructed that it must have just the right amount of blood. If its supply is suddenly withdrawn, a person faints; if the supply is suddenly increased he becomes excited. When

a person is intoxicated his brain gets an increased amount of blood and the poisonous effect of alcohol as well. His actions and speech are then like those of an insane person, until he reaches the stage where stupefaction and sleep overcome him.

Another condition that the brain requires is that the blood which is brought to it should be well supplied with oxygen and perfectly pure, but the blood of a man who has taken any alcoholic drink does not contain so much oxygen as



Normal Ganglion Cell of Spinal Cord.

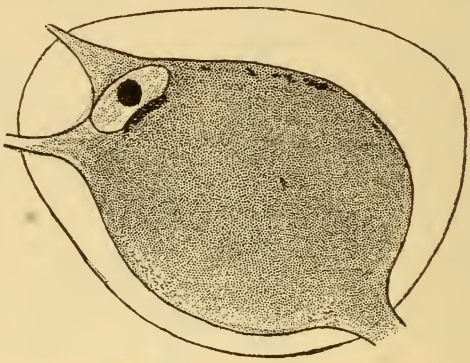
it ought, and it is charged with a poison that irritates the delicate nerves and tissues.

Alcohol affects the cerebrum, which is the seat of thought and reason, much more quickly than the cerebellum, which is the seat of movement and action ; therefore the moral sense seems to be lost, and a man will do violent deeds and brutal

acts which he would never dream of doing were he not temporarily out of his right mind.

His ability to do mental work is also affected. Careful tests with delicate apparatus show that more time is required to receive and respond to a given signal after alcohol is taken than before.

The fact that some mental workers of recognized ability have been moderate drinkers, does not show that alcohol has helped them, and against their example we have the testimony of such men as Helmholtz, a mental worker of prodigious achievements, who said that the smallest quantity of alcoholic beverages seemed to frighten away "the ideas flashing up from the depths of the unknown soul." Hon. A. D. White, our



Alcohol Poisoned Ganglion Cell of Spinal Cord.

Minister to the court of Germany and ex-Minister to Russia, said of the use of such beverages, "I can conceive of no worse preparation for literary work." Profs. Fick and Bunge explain this when they say that alcohol "weakens the critical powers of the mind," and lessens "the control over a train of thought."

Effects of Alcohol on the Spinal Cord. — The nerves, which receive their impulses from the brain through the spinal cord, suffer with the brain; for the ganglion cells are so delicate and so dependent on constant supplies of fresh blood, that when the blood comes poisoned with al-

cohol, the fine cells become altered in their composition and are unable to control the movement of the muscles. Then a person has a peculiar trembling of the hands and limbs, a twitching of the muscles of the face, and a strong sense of uneasiness and restlessness which he calls nervousness. This does not wear off readily, for the nerves are extremely delicate and sensitive ; they are the most highly organized part of the body, and when they become worn out or diseased by the terrible strain put upon them by the effects of alcohol, they do not recover for months, sometimes years.

The nerves and the brain are so intimately connected that a man who is a "nervous wreck" is often not far from the insane asylum. Statistics show that the greater proportion of the insane have become so through drink, either by their own indulgence or from nervous and mental weakness inherited from their parents who were drinkers.

One of the latest authorities (Twentieth Century Practice) on the subject of alcoholism in this country makes the following statement: "It has long been a matter of observation that the man or woman who has a paroxysm of intoxication for a day or two once a month, but who does not drink between times, does less injury to body and brain by alcoholic toxicity (though he may run more risk of accident while intoxicated) than the steady, free, 'moderate drinker,' so called, who, with his four or five daily doses keeps his whole system continuously under the poisonous influence. 'Soaking' or saturating the blood daily with the poison for a long series of years does more damage to the human constitution than a periodic bout."

Hereditary Influence of Alcohol on the Brain and Nervous System. — By heredity is meant the handing down from father to son of certain characteristics of the body or of the mind. This is easily seen in the features of the face, and the first thing that people look for in a little child is to see whether its eyes and nose and mouth are like those of its

father or its mother. Some personal characteristics are also easily seen, as for instance, a quick temper, a ready wit, or a good memory; but there are other inherited peculiarities which are not seen at first sight. For instance, the children of consumptive parents inherit weak lungs, and are very apt to contract consumption. Of all diseases those caused by alcohol and those accompanying the alcoholic habit are not only most likely to be inherited but are most pernicious.

The uncontrollable desire for strong drink can be inherited, so that as soon as the son of a drunkard tastes it the craving may be aroused, just as the first taste of human blood excited the lion's whelp, which a keeper had kept as a pet, and though he had hitherto been as tame as a dog, when the appetite was aroused he killed his master.

The history of most large cities shows that new families are constantly growing to power and wealth from strong and healthy but humble stock. The father makes his fortune by hard work, and a careful abstemious life. His children, accustomed to luxury and society, often form habits of smoking and drinking, and their children—the third generation—born with alcoholic tastes, which they perhaps freely indulge, are apt to go rapidly down hill and become common drunkards.

Considering the terrible inheritance of alcohol, when the question of marriage arises, every young woman should realize that a man who drinks may not only give his children an inherited taste for liquor, but by his example may make them so familiar with it that they will taste it in their youth, and the craving may be aroused. Careful medical research has shown that alcohol produces a nervous state similar to that caused by severe diseases, and that nearly all of the organs of the body are weakened by it; the weakness in these organs may be handed down to the children of parents who drink. Very often such children die when they are born, or in early childhood, for they have poor constitutions. If they grow up

and live careful, temperate lives they may outgrow their weaknesses, but if they are influenced by their parents' habits, and begin to drink, they are apt to contract kidney disease or liver trouble or consumption, or some disease which the alcohol aggravates in a body that has such hereditary weaknesses. If they live to marry, and are drunkards of the second or third generation, their children are apt to die young; thus, a family cursed with alcohol seldom produces drunkards past the fourth generation, and it is said that it "runs out." The fact that the inherited effects of alcohol are limited to three or four generations, by killing a family off by its various accompanying diseases and poverty, does not in the least limit the widespread growth of the habit, for each drunkard, by reason of his social habits, starts other families on the downward path.

There is a more terrible inheritance than drunkenness itself following the use of alcohol, and that is insanity, idiocy, epilepsy, and certain diseases of the spinal cord or brain that produce paralysis or loss of power, so that often the innocent children of alcoholic parents are afflicted with some incurable disease. It is held by some authorities that one-third of the cases of insanity in this country are caused by alcohol, and about one-half of the idiots are children of intemperate parents. In one family where both the parents were drunkards seven of the children were idiots. It is, however, impossible to get full statistics on these facts, because the weakness and the poverty to which the children of drunken parents are born cause a large proportion of them to die in their infancy.

So much, however, has been written upon disease inheritance that a man is apt to say, "I have inherited this taste for drink, and nothing can cure me." But one must not mistake the inheriting a *tendency* to a disease for inheriting the disease itself. A man may inherit an appetite or a desire for drink which, if gratified, would make him a drunkard, but he does not inherit drunkenness, and although he may have drunken parents, the chances are that if he is brought up as

an abstainer, and has strength of will to refuse to begin the habit of taking even a very small amount of liquor, he will never become a drunkard. Further, by appropriate, sound wholesome fare and regular moderate hygienic exercises, his system may be so strengthened and fortified as to throw off these transmitted tendencies.

Even though the patient may have a direct alcoholic or other inebriate ancestry of two or more generations back, he need not despair. Time and time again cases are seen where the gravest family history as to inebriety is present and with other serious neurotic family inheritances, yet these handicapped persons by strong will-power have kept the diseased craving away and have lived noble and helpful lives both for themselves and the community, and have brought healthy normal children into the world.

Effects of Tobacco upon the Nervous System.—The nicotine of tobacco has a peculiar, deadening effect upon the delicate structure of the nerves, that produces a sort of exhaustion. This is the half-sleepy feeling that leads the smoker to say tobacco has "a soothing effect upon his nerves." Its after-effect, however, is to make him irritable and nervous, to cause his hands to tremble and his muscles to twitch.

Effects of Coffee and Tea upon the Nervous System.—Coffee and tea *excite* the nervous system. They are often the cause of nervousness and trembling; also of palpitation of the heart, which is a form of nervousness. Children should not drink coffee or tea, and probably most grown people would be better without them.

The Sympathetic System of Nerves.—Besides the great nervous system to which this chapter has been devoted, there is a smaller collection of nerves, which is known as the *sympathetic system.* Along the front of the backbone are found two nerves, with many knob-like enlargements at numerous points. This is the central part of the sympathetic system, from which the branches of this system are given off. Unlike

the nerves of the general nervous system, which pass to the outside of the body and to parts which are subject to our will, the branches of the sympathetic system pass to the internal organs which cannot be controlled by our will, and which are therefore called *involuntary.* The sympathetic system serves to connect the internal organs so as to make them act in harmony.

SYNOPSIS.

The Nervous System:

1. Present in animals, but not in plants.
2. Functions:

   a. To give information in regard to the condition of various parts of the body.

   b. To give information of what is going on around us, so that we can act accordingly, and can avoid danger.

   c. To connect the different organs of the body, so that they can act in harmony.
3. Divisions:

   a. The general nervous system; nerves passing to external parts, and those controlled by our will.

   b. The sympathetic nervous system; main part arranged in two chains, with knob-like enlargements along the front of the vertebral column; from these branches are given off; branches pass to internal organs which are not under control of the will—involuntary.

The General Nervous System:

Divisions:

A. Brain:

1. Coverings:
   a. Membranes.
   b. Bones forming cranium.
2. Shape—hemispherical.
3. Size—about eight inches long.
4. Weight—*a.* Average about forty-seven ounces.
   b. Heavier in man than in woman.
   c. Very light in idiots.

d. Weighs more in man than in any other animal, except the whale and elephant.

e. In some cases, weight is proportionate to intelligence.

5. Gives off the cranial nerves.
6. Natural rest—Sleep:
   a. Necessary amount varies.
   b. Hard work necessitates more.
   c. Average for man, seven to eight hours.
   d. Children require more, nine to ten hours.
   e. Use, to give body, and especially brain, a complete rest.
   f. Proper time, at night.
   g. Disordered sleep—wakefulness—may be due to laziness, tea, coffee, or tobacco.
7. Divisions:
   a. Cerebrum:
      1. Largest part of brain (seven-eighths).
      2. Large, round mass.
      3. Divided into halves, called hemispheres.
      4. Surface uneven, owing to winding elevations, between which the surface dips in.
      5. The height of these elevations and depressions is proportionate to the intelligence.
      6. Exterior gray and formed largely of cells.
      7. Interior white, and formed entirely of nerve-fibres.
      8. Controls mind, will, thought, memory, and intelligence.
      9. Gives reason and judgment, elevating man above the lower animals.
      10. Admits of training.
   b. Cerebellum, or little brain.
      1. Much smaller than cerebrum.
      2. Forms one-eighth entire brain.
      3. Forms lower and hind part of brain.
      4. Like cerebrum, is gray on outside and white within.

c. Medulla:

1. Connection between brain and spinal cord.
2. Very important part, since injury to one portion causes instant death.

B. Spinal Cord:

1. Long bar of nerve-tissue.
2. Protected by: *a*, membranes.
   b, bones forming vertebral column.
3. Interior formed of gray matter, arranged in crescents, and composed largely of cells.
4. Outside is white and formed of nerve-fibres.
5. Gives off the spinal nerves.
6. Acts as an agent or assistant to the brain.
7. Controls reflex action—action without the knowledge of the brain, serving to protect us from injury.

C. Nerves:

Divisions:

1. According to action: *a*, sensation; *b*, motion.
   (1.) Nerves of sensation, carrying impressions of feeling, such as pain, etc., from the surface to the brain and spinal cord.
   (2.) Nerves of motion, carrying messages from the brain and spinal cord to the muscles, and causing these to act.
2. According to source: *a*, cranial; *b*, spinal.
   (1.) Cranial nerves, twelve pairs, pass from brain, through openings in bone, to various parts of the head and neck.
   (2.) Spinal nerves, thirty-one pairs, emerge from spinal cord by two roots, which soon join together, pass to different parts of the trunk and limbs.

Disorders of the Nervous System, due to:

1. Coffee and Tea:
   a. Often excite nervousness, trembling, etc.
   b. Children should not be allowed any.
2. Tobacco—Often causes nervousness, trembling, etc.
3. Alcohol.
   a. Great enemy to nervous system.

b. Sensations of dizziness, caused by rush of blood to head.
c. Feelings of exhilaration followed by insane actions.
d. Brain-cells irritated by alcohol.
e. Water of brain absorbed, and tissues hardened.
f. Loss of memory, and weakened intellectual powers.

Effect on Nerves:

a. Loss of water from nerve-pulp.
b. Lack of muscular control.
c. General nervous wreck, leading to insanity.

Effect of Tobacco upon Nervous System:

Nicotine has a deadening effect upon nerve-pulp, and causes a soothing feeling, followed by irritability.

The Sympathetic Nervous System—Smaller than general nervous system—Central or main part extends along the front of spinal column—Branches pass to internal, involuntary organs.

QUESTIONS.

1. What different parts are found in plants as well as in animals? 2. What is the skeleton of a leaf? 3. Do plants take in food and drink? 4. How? 5. How do plants breathe? 6. What difference is there in the breathing of plants and of animals? 7. What are pores? 8. What fluid is there in plants corresponding to the blood of animals? 9. How is the sap carried along? 10. Do plants have any warmth of their own? 11. How can you prove this? 12. What part of animals is absent in plants? 13. What is a system? 14. Give an example. 15. Does the nervous system exist in plants? 16. In what animal is there the highest form of nervous system? 17. What is the function of the nervous system? 18. What might happen if we did not have a nervous system? 19. Give an example to show that there must be a chief to everything where there are many parts. 20. Into what parts can we divide the nervous system? 21. What is the office of the brain? 22. What of the spinal cord? 23. What of the nerves? 24. Give an example of the action of the nervous system. 25. Does it take the nervous system a long time to act? 26. Give an example to show how quickly it acts. 27. Where is the brain situated? 28. What protects it? 29. Is it soft or hard? 30. What is its form? 31. What is its size? 32. What is its weight? 33. Is it heavier in man or in woman? 34. Does its weight depend upon the intelligence of the person? 35. Give examples. 36. What can you say about the brains of idiots? 37. Into what parts can the brain be divided? 38. Where is the cerebrum? 39. What are the

hemispheres? 40. What can you say about the surface of the cerebrum? 41. What is peculiar about the surface of the cerebrum in very intelligent persons? 42. How is it different in the lower animals? 43. What is the color of the cerebrum on the exterior? 44. What is the color of the interior? 45. Of what does the gray matter consist? 46. Of what does the white matter consist? 47. Describe the cerebellum. 48. Describe the medulla. 49. Why is it very important? 50. What is a nerve? 51. Where are the cranial nerves? 52. To what are they attached? 53. Name the functions of the brain. 54. What is meant by doing things "by instinct?" 55. Where does the will exist? 56. What is meant by memory? 57. What is intelligence? 58. What is reason? 59. What is judgment? 60. How can we train the brain? 61. What is the spinal cord? 62. How is it protected? 63. What is meant by "breaking the neck?" 64. Of what is the spinal cord formed? 65. How does it look inside? 66. What are the spinal nerves? 67. How many are there? 68. How do they leave the spinal cord? 69. What two kinds of nerves are there? 70. What are the functions of the spinal cord? 71. What is reflex action? 72. Give an example of reflex action. 73. Of what use is reflex action? 74. What is sleep? 75. How must the brain be rested? 76. What is the average amount of sleep required for a man? 77. How much for a child? 78. What are the uses of sleep? 79. What is the proper time for sleep? 80. When should children go to bed? 81. When should they rise? 82. What is nervousness? 83. What is nervousness due to? 84. What is wakefulness? 85. What are some of the most common causes? 86. Is it natural for us to feel a little tired at night? 87. Why can some persons who are idle all day long not sleep at night? 88. How do coffee, tea, and tobacco act on the nervous system? 89. What effect has alcohol upon the nervous system? 90. How is the brain affected in drunkenness? 91. How are the nerves affected? 92. What effect has tobacco on the nervous system? 93. What effect have coffee and tea on the nervous system? 94. What is the sympathetic system of nerves? 95. What is the function of the sympathetic system? 96. What is its arrangement? 97. To what parts is the sympathetic system distributed?

CHAPTER XIV.

THE SENSES.

There are certain organs in the body which add a great deal to our comfort and enjoyment and give us knowledge and pleasure. The functions of these organs are called the *senses*. There are five of them.

1. Touch—The *skin*.
2. Taste—The *tongue*.
3. Smell—The *nose*.
4. Sight—The *eye*.
5. Hearing.—The *ear*.

Special Senses.—They are often called the *special senses* because each one has a special duty to perform and cannot be used for anything else ; as, for instance, our eyes can be used for seeing only. The skin is the only one of these organs which is necessary to life ; and it is an organ of *general* rather than of special sense.

THE SENSE OF TOUCH—THE SKIN.

Thickness.—The skin forms a soft, elastic layer which covers the entire body. It is not of the same thickness in all places. It is thick at certain places where the body is very much exposed or where there is much friction, as in the palms of the hands and the soles of the feet. In other places which are more protected, it is quite thin ; as, for instance, the inner side of the arm.

Uses of the Skin.—As has already been stated, the skin is necessary to life. In certain accidents, in which a per-

son has burnt or scalded himself severely, he may die because too much of the skin has been lost. There are four principal uses of the skin: (1) As a *protection* to the entire body; (2) as the *organ of sensation* or feeling; (3) to *throw off water, salts, and poisonous matter* from the body; (4) to *regulate* the bodily *warmth.*

The Skin as the Organ of Sensation or Feeling.—The nerves of sensation or feeling end in the skin in little knobs, which are the portions with which we feel the different sensations, such as heat, cold, smoothness, roughness, pain, etc. Some parts of the body are more *sensitive* than others. This is because they have a greater supply of these nerves. These same nerves also give rise to pain, which is useful, as it protects the body, and tells you when to be careful. If you are holding a lighted match in your fingers, you will drop it as soon as it burns down to your finger-tips because there is pain. If there were no pain to warn you, the ends of the fingers might have been burnt off before you were aware of it. With these nerves we are enabled to feel whether anything is smooth or rough, sharp or dull, cold or warm, soft or hard. The finger-tips are intended as the organs of touch. In the blind, the sense of touch becomes very much developed, and such persons can be trained to do wonderful things by means of the fingers. The books of the blind are printed with letters which are slightly raised; and it is marvellous how quickly they can spell the words by means of their fingers.

Throwing off Water, Salts, and Poisonous Matters.—This is a very important use of the skin. If an animal were to be covered with paint or varnish so as to close all the pores, death would result in a short time.

Regulating the Bodily Warmth.—The skin serves an important purpose in regulating the bodily warmth. It does this by increasing or diminishing the amount of perspiration, thus cooling the body in summer by permitting free perspiration.

Structure of the Skin.—The skin is formed of two layers (Fig. 86). The outside layer is called the *scarf skin*, the deeper one the *true skin*.

The *scarf skin* is formed of a great many scales or flat cells covering each other; and these cells are being constantly rubbed away and cast off, and are then replaced by new ones. In taking a bath, for instance, it will be noticed that in drying a little of the skin comes off. This material is formed of the dead cells which are cast off. The scarf skin of the scalp is often cast off in small scales which we call *dandruff*. This throwing off of these scales from the skin of the body takes place all the time and is natural. In snakes the scarf skin is thrown off in one piece and forms the very pretty tubes sometimes found in the fields.

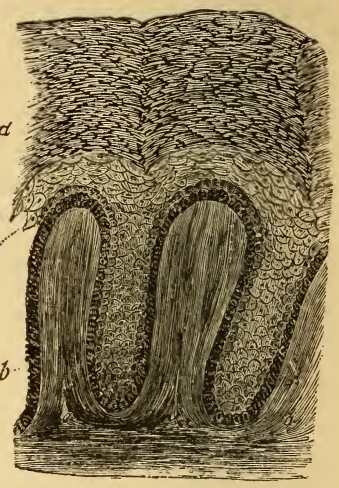


FIG. 86.—A Piece of Skin as Seen Under the Microscope. *a*, The layers of flat cells forming upper layer of the scarf skin; *c*, deeper layer of scarf skin; *b*, projections of true skin.

The *true skin* is the part which contains the blood-vessels and the nerves; also the roots of the hair, the perspiration tubes, and the oil tubes. If you burn yourself, a blister forms, which separates the scarf skin from the true skin; if you lift up the blister, the red part you see underneath is the true skin. The true skin is not perfectly smooth, but has a number of small projections upon it. But these do not appear on the surface of the skin because the cells of the scarf skin fill out the uneven places (Fig. 86).

Color of the Skin.—The skin is colored differently in different parts of the body. It is darker, for instance, on the back of the hand than on the arm. Some persons have very light-colored skin and are said to have a fair complexion, and

these usually have blonde hair. Others have dark complexions and usually have hair of a dark shade. In the negro, the skin is dark brown. This difference in the color of the skin depends upon the amount of coloring matter which is found in the true skin. In white people there is very little of this, in the negro there is a great deal of it in the form of small dark brown grains.

If you look at the skin of the palms of the hands, especially at the finger tips, you will see fine lines arranged in circles. If you examine these with a magnifying glass it will be seen that the lines are raised, and it is here that the nerves of feeling end in great numbers.

Attachments of the Skin.—Upon examining the skin, we find in it, or attached to it, certain parts: *Perspiration tubes, oil tubes, hairs,* and, in certain parts, *nails.*

The Perspiration Tubes.—These are the small tubes in the skin, which give off the perspiration. There are a great many of them. Where they open upon the skin there is a small space called a *pore.* There are thousands of these pores in the space of every inch of the skin. This shows the *necessity of keeping the body clean,* so that the pores remain open, for otherwise the perspiration cannot escape. The perspiration tubes open upon the surface of the skin; below, they commence by a series of windings in the deeper parts of the skin, as is shown in Fig. 87.

The Perspiration.—Perspiration is constantly being given off from the body, day and night. Most of the time, especially when the weather is cool, it is invisible, and hence is called *insensible* perspiration. But if more than the usual amount is given off from the skin, the perspiration collects in drops and is called *sensible* perspiration. This occurs in summer and at other seasons of the year when we become overheated or work hard. Perspiration consists largely of water; and in the water certain mineral salts and certain poisonous matters which it is necessary for the body to cast off are dissolved.

Uses of the Perspiration.—It has just been stated that the perspiration *takes from the body water, salts, and poisonous matters.* Even when the weather is cold and perspiration is insensible, about a pint of water leaves the body daily by the skin ; and in summer much more than this escapes. This will give an idea how many of these perspiration tubes there must be and how active they must be. Perspiration is also very important because it *cools off the body*, as has already been described in the chapter on The Heat of the Body.

FIG. 87.—One of the Perspiratory Tubes. (Greatly magnified.) The tube is seen to pass through the entire thickness of the skin, through its different layers.

The Oil Tubes.—Besides the perspiration tubes, there are others which run through the skin and open on or near its surface, usually where there is hair (Fig. 88). These tubes give off a certain oily substance which keeps the skin soft and movable, without which the skin would get dry and cracked. This oily matter also serves to keep the hair glossy and soft ; and we find the greatest number of oil tubes where there is hair. It is to remove the oily matter which has become stale that we need soap in washing. Sometimes there is too much of this oily matter and then the skin has a greasy look, such as we often see on the forehead and nose. Sometimes these oil tubes become stopped up by a little dirt ; and as a result the oily matter is kept in and we see a black spot on the nose or forehead. This is often called a worm, but it is no worm, but simply the oily matter which cannot escape because the opening of its tube has become clogged up.

The Hair.—If a hair be examined it will be found that one end is pointed, while the other, which was attached to the skin, has a white knob, called its *root*, and it is through this that it is fastened to the skin (Fig. 88). The hair is not

solid but is a tube, and has a canal in its centre filled with a soft material. Deep in the skin there are small cup-like spaces into which the root of the hair fits and is attached. Hair differs very much in color, and this is because there is a difference in the amount of the coloring substance present in different cases.

The Nails.—At the end of the fingers and toes are the nails. They are hard and horny and serve to protect the finger tips and give them firmness. In front they have no feeling and we may cut them without paining us. But further

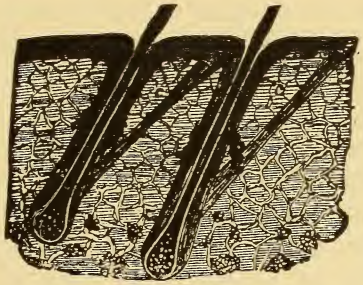


FIG. 88.—A Piece of Skin Cut Across to Show the Way in which Hair is Attached to the Skin. (Highly magnified.) There is seen to be a depression in the skin into which the hair dips. Below, the round, expanded extremity or root of the hair is seen. Two oil tubes are seen opening along the side of the hair near the surface of the skin.

back they are very firmly attached to the back of the finger and here they are very sensitive.

Care of the Skin.—You will now appreciate how important the skin is, and why it is necessary to keep it in good condition. *Cleanliness is next to Godliness* is an old saying; if you wish to be healthy you must be clean. Dirt is, as a rule, a sign of ignorance; and those nations are usually the dirtiest which are the most backward in civilization. On the other hand, the more civilized people are the cleaner do they keep themselves. There are few things that cause so much disease as *uncleanliness and filth.*

The Results of Uncleanliness and Filth.—Whenever you read of outbreaks of cholera and such diseases you

will always find that they occur in parts of cities which are overcrowded and filthy. This was shown in the last outbreak of cholera many years ago in New York. It is easy to understand why this should be so. The pores of the skin are the openings by which the body gets rid of waste materials, just as the sewer pipes of a city carry off the refuse. Suppose the sewer becomes stopped up in a large city, what trouble it causes! What dirt! What a stench! In the same way, when we allow the dirt to cover the pores of our skin, the poisonous materials cannot escape, and the body suffers. In taking proper care of the skin it is necessary to pay attention to *bathing*, to our *clothing*, to *exercise*, and to *avoid* using *powder* or any like substance upon the skin.

Bathing.—It is not sufficient to wash the hands and face daily; we should wash off the entire body at least once a week. If you shake out some of your underclothing at night, you will find a great many small white flakes fall to the ground. They represent the uppermost layer of the skin which is constantly being cast off in these small particles and replaced by the deeper layers. The entire body is covered with these scales, and it is necessary to remove them often. Some fall off by themselves, but others must be removed by soap and water. Consequently, at least once a week we should take a warm bath, and use soap in it, for this removes the stale, oily matter also.

Cold Baths.—Besides the warm bath for the sake of cleanliness, we should take cold baths, especially in summer, because they are *refreshing and strengthening.* After taking a cold bath it is well to rub the body with a coarse towel so as to make the skin glow and tingle. This causes the blood to circulate faster, and increases our strength and appetite. It is injurious to remain in a cold bath until you begin to shiver. As soon as you *begin to feel chilly you should go out.* Many persons are harmed by cold bathing because they remain in the water for too long a time. Some persons are naturally

weak, and when they take a cold bath they are not able to withstand its effects, so that even though they rub the body afterward they still feel cold and chilly; which is a sign that they are unable to endure cold bathing. Such people should be content to simply sponge off the body with cold water, besides taking a warm bath about once a week for the purpose of cleansing the body. *Never bathe directly after a meal;* wait two or three hours. If you are overheated and perspire freely, it is better to wait until you are somewhat cooled off before you go into cold water. Always *wet the entire head* as well as the rest of the body when bathing.

The Turkish and the Russian Bath.—Probably all of you have heard of the Turkish bath and the Russian bath. In the *Turkish bath*, the person is kept in a room with very hot air until he perspires freely; he is then scrubbed with soap and water; then he plunges into a cold water bath; next his skin is rubbed and his muscles kneaded by men who are employed for this purpose. This causes the blood to flow faster; then the person rests himself thoroughly before going out into the air. The *Russian bath* is similar, the only difference being that the room is filled with steam instead of hot air, to make the person perspire freely. These baths are good for grown people, but are not suitable for children.

Clothing.—In the chapter on The Heat of the Body something has already been said about proper clothing, so that little need be added here. We should change underclothing frequently. It is a healthy practice to take off all our underclothing at night and allow it to hang up and be thoroughly aired before putting on again the next morning.

Exercise helps to keep the skin in good condition by making us perspire more freely, and in this way keeping the pores open. It also causes the blood to circulate through the skin more rapidly, which gives us the delightful feeling of warmth after exercising.

Cosmetics.—The use of powders and like substances

upon the skin is very injurious. These substances, which are called *cosmetics*, stop up the pores and make the skin rough and ugly. Besides, many of them are poisonous, and this poison may get into the blood through the skin and poison the body. Powdering the face is not done by the better class of people.

Care of the Hair.—The hair should be combed and brushed every morning. Every few weeks it will be necessary to wash it with soap and water. The oil tubes of the scalp usually supply enough oily matter to keep the hair glossy; hence the practice of putting *oil or grease* on the hair is not only *very vulgar and nasty* but it is unnecessary. *Crimping* the hair by hot irons destroys the hair and makes it fall out. *Hair dyes* are injurious; nearly all are made of deadly poisons, which may get into the blood and poison the entire body.

Care of the Nails.—The nails should be cut with scissors at regular intervals. The finger nails should not be bitten off. The nails should not be cut too close or else the finger tips and the ends of the toes will become sore. Many persons have sore toes, especially the big toe, because they do not cut the nail properly. It should be cut straight across and not rounded and short (Fig. 89). *Hangnails* often result from biting the nails or keeping the fingers in the mouth.

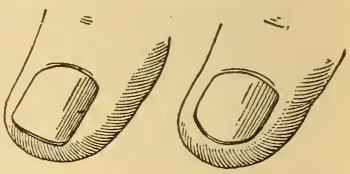


FIG. 89.—Proper and Improper Method of Trimming the Toe-nails. The figure to the left exhibits the proper method—cut off squarely; that to the right the improper method — cut off round and close.

Effect of Alcohol on the Skin.—An experienced physician can tell by a glance at a patient's skin whether he is in the habit of taking alcoholic drinks. At first the skin has a soft feeling and perspires easily; then it begins to get coarse and thick, eruptions may break out on it, and finally the nose and cheeks become swollen and covered with a network of fine red or purple veins, which tell the tale of the drinking habit as plainly as words. The alcohol in the blood

excites the skin to greater activity to get rid of it, and in course of time the overworked blood-vessels are enfeebled, the veins become permanently engorged, the tissues are congested, and the skin cannot perform its natural functions in the proper way. The skin and the kidneys are the main organs for the excretion of waste products of the body and act in harmony, each one sharing a portion of the work. The kidneys are very susceptible to the influence of alcohol, and are among the first organs to become diseased by its excessive use. As soon as their functions are enfeebled more work is required of the skin, but owing to the deleterious effects upon it, it is not so able to carry on the extra work ; therefore it reacts again on the kidneys, with the result that the habitue of the saloon, sooner or later, is liable to become the victim of an incurable disease.

SYNOPSIS.

The Skin:

1. Thickness—Varies in different parts of body.
2. Uses:
   - *a.* Protection.
   - *b.* Organ of sensation or feeling:
     1. Acuteness varies in different parts of body.
     2. Greatest at finger-tips.
     3. May be developed, as in the blind.
     4. Depends on the nerves of sensation, ending in the skin by small knobs.
   - *c.* To throw off water, salts, and poisonous matters from the body.
   - *d.* To regulate the bodily warmth.
3. Structure:
   - *a.* Scarf-skin on the outside.
   - *b.* True skin beneath.
4. Color:
   - *a.* Varies in different parts of body.
   - *b.* Varies in different races.
   - *c.* Depends on the amount of brown coloring matter existing in the true skin.
5. Attachments:
   - *a.* Perspiration-tubes—Openings called pores; necessity for keeping open; perspiration, sensible and insensible; removes matters from body and cools body.
   - *b.* Oil-tubes—Keep skin soft and hair glossy and soft; necessity for using soap to remove stale oily matter.
   - *c.* Hair—Root and point; hollow; color varies; should be combed and brushed daily; should be washed every few weeks; no oil or dyes.
   - *d.* Nails—Should be cut regularly, not bitten off; cut across square.
6. Care of Skin:
   - *a.* Cleanliness.
   - *b.* Bathing:
     1. Warm bath and soap for cleanliness.
     2. Cold bath, refreshing.

3. Turkish bath. 4. Russian bath.
5. No cold baths for those too weak to stand them.
6. No bathing directly after meals.
7. No bathing when overheated.
8. Wet head as well as rest of body.
9. Rub body well with coarse towel after bath.

c. Clothing—Necessity for changing underclothes frequently.

d. Exercise.

e. Cosmetics—To be avoided.

QUESTIONS.

1. Name the special senses. 2. Is the skin of the same thickness throughout the body? 3. At what points is it the thickest? 4. What are the uses of the skin? 5. Is it necessary to life? 6. How is this proven? 7. Of what service is pain? 8. Of what use are the nerves of feeling? 9. What parts of the body are intended especially for feeling? 10. What is peculiar of the touch of the blind? 11. What is discharged from the body by means of the skin? 12. What effect has the skin upon the bodily warmth? 13. Is the color of the skin always the same? 14. Upon what does the color of the skin in the negro depend? 15. Of how many layers is the skin formed? 16. What are these layers called? 17. Of what is the scarf-skin formed? 18. What becomes of the scales which form the scarf-skin? 19. What is dandruff? 20. Describe the true skin. 21. How do the two layers of the skin become separated in slight burns? 22. Describe the perspiration tubes. 23. What are the pores? 24. What is insensible perspiration? 25. What is sensible perspiration? 26. What are the uses of perspiration? 27. What does the perspiration remove from the body? 28. About how much perspiration leaves the body every day? 29. How does perspiration cool off the body? 30. What appearance does the skin of the finger-tips present? 31. What other tubes are there besides the perspiration-tubes? 32. Of what use is the material which the oil-tubes produce? 33. What happens when the oil-tubes get stopped up? 34. Why does the skin of the nose and forehead sometimes have a greasy look? 35. Describe a hair. 36. How is hair attached to the skin? 37. Of what use are the nails? 38. Why is cleanliness so very important? 39. Of what is dirt a sign in regard to civilization?

40. What effect upon the health has filth? 41. Why is filth so bad for the health? 42. How often should the entire body be washed? 43. Why should the entire body be washed frequently with soap and warm water? 44. What are the effects of a cold bath? 45. What should we do to make the circulation more brisk after a cold bath? 46. What is the sign that you have been in a cold bath long enough? 47. Is it well to bathe directly after a meal? 48. What other precautions should you take when bathing? 49. Explain the Turkish and the Russian bath. 50. Should we wear the same underclothing at night that we have worn during the day? 51. How does exercise affect the skin? 52. What are cosmetics? 53. What effect have they upon the skin? 54. What should be done to the hair? 55. What can you say about the practice of putting oil or grease upon the hair? 56. What are most hair dyes made of? 57. How should the nails be cut?

THE NOSE—THE SENSE OF SMELL.

Functions.—The nose is the organ with which we *smell.* It is also the part through which the *air* is *drawn.* The

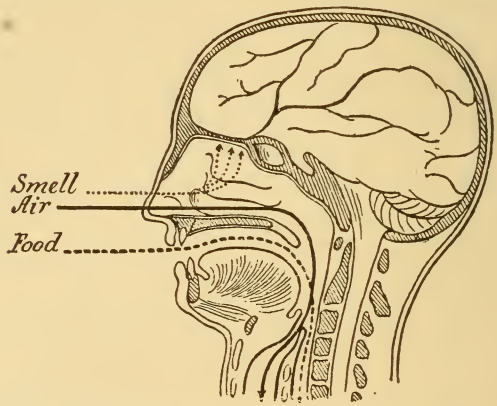


FIG. 90.—Diagram Exhibiting the Channels by which Smell, Air and Food Reach the Interior of the Body.

lower part of the nose represents a passage for *breathing,* the *upper portion* is the part devoted to the sense of *smell* (Fig. 90)

The Breathing Channel and the Smelling Channel.—When we *breathe* we draw the air *backward* through the lower part of the nose. This part of the nose runs horizontally backward, and behind joins the throat; so that if a fluid is poured into the nose it will run into the throat. When we *smell*, we draw the air *upward*, because we want the odor to ascend to where the nerves of smell are.

Parts of the Nose.—The nose is formed of *bones and gristle.* The hard part on the outside, where usually people wear their eyeglasses, is formed of two small bones and is called the *bridge* of the nose. In looking into the nose we find that it is divided into two halves. The openings in front are called the *nostrils.* In the interior of the nose on each side are found *three shelves of bone* covered by a soft membrane; and beneath each shelf is a passage-way which runs from the front to the back of the nose.

The Nerves of Smell.—In the membrane which covers the two upper shelves just described, are found numerous nerves, the *nerves of smell.* By consulting Fig. 91, it will be seen that the brain lies immediately above the nose. These nerves of smell come in bunches from the brain, and descend into the nose. Although we are in the habit of saying that we smell with the nose, it would be more correct, strictly speaking, to say that we smell with the front part of the brain. The nerves of smell merely serve to carry the odors to the brain. This is proved by the fact that there is a loss of the sense of smell if the front part of the brain be injured or diseased, even though the nerves of smell still be present.

The Sense of Smell in the Lower Animals.—Many of the lower animals have a much more acute sense of smell than man. Dogs and cats, for instance, can smell the faintest odors at great distances. In hunting dogs the sense of smell is extraordinarily acute; they can smell game miles away and for this reason are valuable in hunting. This is spoken of as *scenting the game.* Before the civil war, blood-

hounds were employed to track runaway slaves, and they were able to do this owing to the acuteness of their sense of smell.

Cold in the Head.—Almost everyone has caught cold at some time. When we catch cold it may settle in any part of the body; it may attack the lungs, or the stomach, or some other organ. When the cold settles in our head we usually

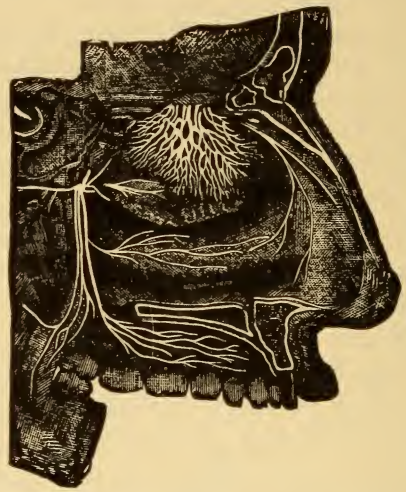


FIG. 91.—View of the Interior of the Nose, showing the Nerves of Smell Descending into the Nose from the Brain, in the Form of a Bunch.

feel it principally in the nose and throat. We often get a sore throat and our nose feels stopped up so that we cannot smell, and we cannot breathe through it, because there is too much blood in it.

Cold in the head is oftenest due to sitting or standing in a draught, or to going suddenly into the cool air when we are overheated, without putting on some additional clothing. Very often we know that we have been imprudent in this way and can feel the cold coming on, and then a mustard foot-bath may prevent it.

Use of the Sense of Smell.—With the sense of smell we are able to enjoy *agreeable odors.* But what is im-

portant is, that we are also able to smell *bad odors*, thus *protecting* the body by informing us of the whereabouts of obnoxious things which should be avoided, especially of *impure air*. It enables us to *select* the proper *food*, and to refuse that which is unfit to eat. It often protects our bodies and homes by enabling us to smell smoke and in this way to discover the existence of a fire.

Sweet Scents.—To smell the sweet odors which flowers give off, is very agreeable. Odors are given off by the oils existing in the flowers of plants. These oils are extracted from the flowers, and this is then called *perfume*. Many persons use this perfume to put upon their handkerchiefs and clothes so that they may smell sweet; but, as a rule, the most refined people do not use perfumes. If you always keep the body clean and brush your teeth often you will not need any perfume; for if the body is clean, it always smells sweet. Soap and water are better than perfume to tidy people.

Effect of Alcohol and Tobacco on the Sense of Smell.—The sharp, biting effect of tobacco upon mucus membranes, as well as the irritating effect of alcohol, causing a redness and an inflammation of the linings of the throat which extends up the pharynx and the sensitive linings of the nose. The smoker's habit of exhaling smoke through the nostrils adds to the smarting sensation. The tears which are started to wash away any foreign source of irritation do not relieve it, but as the smoking continues the membranes become thickened. If the person is subject to catarrh, the irritation aggravates it. Gradually the delicate olfactory nerves that have their endings in the mucous membrane become hypertrophied or deadened, and the sense of smell is dulled. Cases have been known where cancer of the nose is said to have been caused by the excessive use of tobacco. In hard drinkers the sense of smell is notoriously deficient, and in certain occupations where this sense is of importance, those employed cannot drink and work at the same time.

SYNOPSIS.

The Nose :

1. Parts :
   - (1.) Two bones forming bridge.
   - (2.) Gristle.
   - (3.) Two nostrils.
   - (4.) Three shelves running from front to rear.
   - (5.) Shelves covered by soft membrane.
   - (6.) Membrane of upper two shelves supplied with
   - (7.) Nerves of smell which descend in a bunch from brain.
2. Functions :
   - (1.) Lower passage for air.
   - (2.) Upper part for sense of smell.
     - *a.* Great acuteness in some of lower animals.
     - *b.* Blunted in cold in head.
     - *c.* Use—To protect us from impure air and improper food.

QUESTIONS.

1. What are the uses of the nose? 2. Which part of the nose serves for breathing? 3. Which part is used for smelling? 4. Of what is the nose formed? 5. Where is the bridge of the nose? 6. What are the nostrils? 7. What do we find in the inside of the nose? 8. Where are the nerves of smell? 9. Where do they come from? 10. How is the nose connected with the throat? 11. Where do we find the more acute sense of smell, in man or in the lower animals? 12. Give an example. 13. What is meant by a cold in the head? 14. What is this often caused by? 15. What are the uses of the sense of smell? 16. What parts of plants usually give off the sweet scents? 17. What can you say about the habit of using perfume upon the handkerchief or clothing?

THE TONGUE AND THE SENSE OF TASTE.

The tongue is the organ with which we taste our food.

Structure of the Tongue.—This organ consists

almost entirely of *muscle* tissue. Its under surface is smooth, and its upper surface very rough. This roughness is due to a large number of small *projections*. These can be seen better in the lower animals than in man, and serve two purposes:

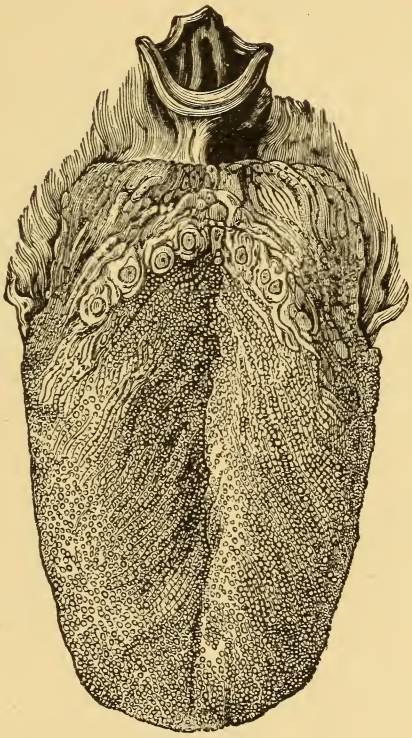


FIG. 92.—The Human Tongue; above, the Epiglottis is also seen.

First, they are the parts which give us *taste;* the nerves of taste ending in rounded extremities in these elevations. The other use is to *feel the food* in our mouth and to discover whether it is chewed sufficiently fine, and mixed enough with the saliva, before it is swallowed. The lower animals, as dogs

and cats, are enabled to scrape off bones by means of these projections.

Uses of the Tongue.—The uses of the tongue are: (1) as the *organ of taste;* (2) to *revolve the food* in the mouth, to *mix* it *with* the *saliva*, to separate hard portions of food, as seed and shells, and to *assist* in *swallowing;* and (3) as the principal organ *in speaking*. The importance of the sense of taste need not be pointed out especially. It enables us to choose our food and to avoid what is unfit to eat; it prevents us from eating improper food; it increases the appetite and makes us enjoy our meals when the food is to our liking.

Abuse of the Sense of Taste.—The sense of taste adds much to our enjoyment. It is necessary, however, to prevent it from enjoying too many liberties, otherwise we shall be *eating too much*, become gluttons, and suffer in health. In selecting our meals, we should be guided by what is wholesome, nourishing, and digestible, as well as agreeable.

Effects of Alcohol and Tobacco on the Taste.—The sense of taste is blunted by the continual use of alcoholic drinks and by tobacco. All delicate flavors are lost to the man who indulges in them continuously, and unless his food is very highly seasoned with pepper or curry or other irritant condiment it tastes flat and insipid to him. In this way he loses his appetite, and is apt to have indigestion from the immoderate use of highly seasoned foods. The tongue is often parched and coated and barked, and the breath offensive and foul; frequently there is intense thirst and a loathing for all food. The cook often comes in for a reprimand for a poor dinner, when in reality it is the alcoholic taste of the diner that is at fault.

The taste of tobacco, especially when chewed, is sharp and biting to the tongue, and causes the saliva to flow freely. This is nauseating and poisonous to swallow, so it leads to the disgusting habit of expectoration. In the meantime the natural supply of saliva is diminished, and there is not enough to aid in the digestion of food.

Cigarettes are particularly harmful to the throat, as is all tobacco smoking. It causes a roughness and chronic inflammation that interferes with public speaking and singing, and if there is any disease of the throat, it aggravates it.

SYNOPSIS.

The Tongue.

Structure—

1. Formed of muscle-tissue.
2. Smooth on under surface.
3. Rough on upper surface, due to
4. Small projections which serve to
   - *a.* Feel food to see if properly chewed.
   - *b.* Taste with, since nerves of taste end here.

Uses—

1. Organ of taste.
2. To revolve food in mouth, mix it with saliva, remove hard portions, and assist in swallowing.
3. To assist in speaking.

QUESTIONS.

1. Describe the tongue. 2. Of what kind of tissue is it made up? 3. Which surface is rough? 4. What is this roughness due to? 5. Of what use are these small elevations? 6. What are the uses of the tongue? 7. What are the uses of the sense of taste? 8. How might we abuse the sense of taste?

THE EYE AND THE SENSE OF SIGHT.

Protections to the Eye.—The eye is one of the most delicate organs in the body. It is placed in the large opening in the skull found just below the forehead, on each side of the nose, called the *orbit*. This affords it considerable *protection*. Besides this, it is also protected by the *eyebrows*, *eyelids*, and *eyelashes*. In the orbit the eye rests upon a soft *cushion of fat*.

The Eyelids.—These serve to protect the eyes by their quick movement in closing, thus keeping out dust. They keep out the light when too strong, or during sleep.

The Eyebrows and Eyelashes.—These keep the perspiration from rolling into the eyes, and keep out dust. They should never be cut, for this will not cause them to grow any longer and injures them by making them thick and stiff.

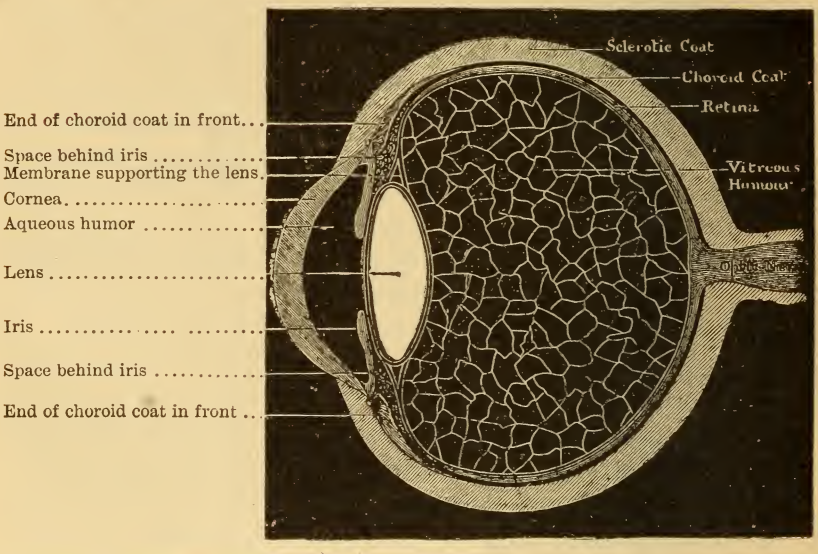


FIG. 93.—The Human Eye (Cut Across and Enlarged), Showing Its Different Parts and the Interior.

Parts of the Eye.—The eye is *spherical in shape*, and measures about an inch in diameter. Its front portion is perfectly transparent, and is called the *cornea.* But behind the cornea, which forms about one-fifth of the circumference of the eyeball, it is opaque and white, and can be separated into three layers, or *coats.* The outermost layer is hard and strong, and it preserves the form of the eyeball; it is called the *white* of the eye, or the *sclerotic coat.* The middle layer is dark-colored, and is called the *choroid coat.* The inner layer is called the

retina, and is of great importance, because the nerve of the eye sends its branches to it, and it is the portion of the eye with which we see (Fig. 93).

Looking into the eye, we see in the centre a black spot which is called the *pupil*. It is a round opening in a membrane which acts as a partition to this part of the eye. This membrane is a colored ring which surrounds the pupil and is really a curtain hanging behind the clear part of the eye. It is called the *iris*.

Behind this curtain, the iris, is a round transparent body, about the size of a cherry-pit, which is called the *lens*. It is perfectly clear and its shape is like that of a small magnifying glass; but it is softer, like a hard jelly. It is supported behind the iris, just where the transparent part of the eye joins the opaque portion, by a delicate membrane, and is round, but flattened somewhat in front and behind.

The *interior of the eye* is filled with *fluid*. Just behind the cornea, extending to the lens, is a space which is filled with a *watery fluid* called the *aqueous humor*. The rest of the eyeball (behind the lens) is filled with a clear substance like white jelly, called the *glassy body* or *vitreous humor*.

The Iris.—It has just been explained that this is a curtain placed in front of the lens of the eye. There is a round opening in the centre, by which light is admitted to the eye; this is the *pupil*. The pupil *changes its size* very often. When we look at anything in the distance the pupil becomes large; when we look at objects close by it becomes very small. The pupil also regulates the amount of light which should enter the eye. In going into a bright light, as for instance into the sun, the pupil becomes very small; if it did not do so the light would be too bright and would injure the eye. It is very dangerous to the eye to try to look at the sun. In the twilight, when the light is dim, you will notice that the pupil becomes very large.

The Muscles of the Eye.—It is wonderful how rapidly the eyes move; but this is necessary to protect the body. The rapid motion of the eyes is also necessary so that they can act together. If you were to press upon one eye so that it could not move, and then were to move the other, everything would look double; so that the two eyes must move together if we want to see singly and plainly. There are six small muscles (Fig. 94) attached to each eye, which make its movements so rapid. Sometimes one of these muscles does not act so well as it should; then the eye turns in all the time

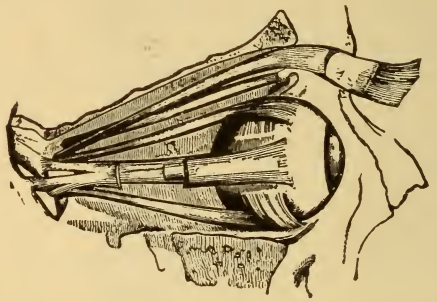


FIG. 94.—The Muscles Attached to the Eyeball and to the Upper Lid.

or constantly looks outward; the person is then *cross-eyed*, or *squints*. Some children are born this way and it is not right to make fun of them. Sometimes children turn their eyes so as to imitate cross-eyed persons—a very injurious habit.

How We See.—It may seem strange to say that we really *see with the brain*, but such is the case. Of course the eyes are necessary, and without them we should be blind; but the brain is also necessary for sight. If a certain part of the brain be injured we cannot see, even though our eyes remain as clear and bright as they were before.

Resemblance of the Eye to a Photographer's Camera.—The eye resembles the box which the photographer uses to take pictures, and which is called a *camera*. Let us see how it resembles the photographer's camera. In the first place

the photographer cannot take a picture in the dark, nor can we see in the dark. Secondly, in the front of the camera there is a lens of glass; we also have a lens, though it is of course not of glass, but of a better and softer material. Again, in the back of the photographer's camera is a glass plate, upon which the picture falls and is taken; in the same way in our eyes the retina serves as a plate upon which to take the picture. Anything which we see forms an image upon the retina. This image lasts only a short time, but long enough for us to see it. Finally, you have probably noticed how the photographer puts a black cloth over his head and the back of the camera so as to keep it dark; the middle, colored coat of the eye—the choroid—serves to darken the inside of the eye.

The Nerve of the Eye.—Connected with the back of the eye is a portion resembling a cord, which passes to the brain. This is the *optic nerve*, or nerve of the eye. It is the nerve which connects the eye with the portion of the brain used in seeing. On arriving at the eye the nerve spreads out in the interior of this organ and forms the innermost layer, which is called the *retina*. By looking into the interior of the eye with an instrument, the oculist can see this layer. It is shown in Fig. 95, the central spot being where the nerve enters the eye; at this point blood-vessels also enter the eye and ther divide and spread out in a very pretty manner.

Blindness.—If the optic nerves of both sides become diseased, or both retinæ become changed, the person may become totally blind, even though the eye appears perfectly healthy on the outside. These nerves carry the sight from the eye to the brain, with which seeing is really done.

Images.—The word image has been used and will require some explanation. If you look into a mirror you will see your face—this is an image of your face. The light strikes your face and from it passes to the mirror; there it forms an image; from this image the light passes into the eye and forms another image upon the retina, which we see.

The Tears.—The eye is constantly kept moist by being bathed with tears. At the outer part of each eye be-

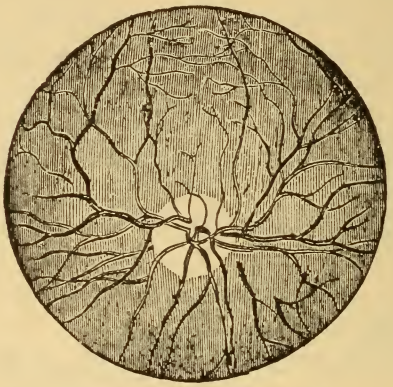


FIG. 95.—A View of the Interior of the Eye, as Seen with the Oculist's Instrument.

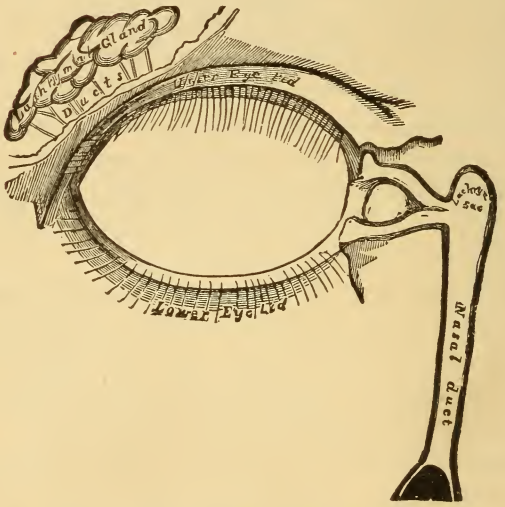


FIG. 96.—The Lachrymal Gland, Sac, and Duct.

tween it and the bone forming the roof of the orbit, is a small body called the *lachrymal gland* (Fig. 96), meaning *tear-gland.* This body is constantly pouring the tears over the eye so as to

keep it moist. Even during sleep this takes place, though there is then much less produced. When we are awake the eye is moving constantly and this movement spreads the tears over the eyeballs. After the tears have moistened the eye, they are collected again and escape into the nose. If you look at your lids you will notice near the inner corner of the eye, a small spot about the size of a pin's point. There is one of these on the lower lid and one on the upper. The tears pass into these openings and then into a small bag near the nose, called the *tear-sac;* then they are carried down into the nose by a tube called the *tear-duct*, or *nasal duct* (Fig. 96). You have noticed how the nose runs after crying. This is because there is so much more of this fluid discharged into the *tear-duct.* If anything gets into the eye, the lachrymal gland produces more of the tears and they flood this organ until the intruding body is swept away. If we become very sad or very angry, tears become very abundant.

Care of the Eyes.—There is no organ in the body which contributes so much to our comfort, our enjoyment, and our knowledge, as does the eye. And yet the eye is constantly being misused. If you have good eyesight you should take care of your eyes so that it does not get bad, and if your eyesight has already become bad you should see that it does not get worse. Some of the *most common rules for the care of the eyesight* are the following:

After having read a long time, it is well to stop and *rest the eyes;* for the eyes, like any other part of the body, cannot be used continuously. It is quite natural that the eyes should feel tired and begin to pain after we have used them a long time; this is nature's sign that they need rest.

Never read in a *poor light.* You may be finishing a chapter in your book and you notice that it is beginning to get dark, yet you do not stop until you get to the end of the chapter even though you strain your eyes. This is wrong and the eyes suffer for it.

Never read *very fine print* if you can help it.

In reading, have the *light come over your shoulder* and thus fall upon the book or paper without going directly into your eyes. It is better to sit with your back to the window and thus have the light come over your shoulder, and preferably over the left shoulder. This precaution is especially useful at night, for the glare of the gaslight or lamp is very tiring to the eyes; while if the light is behind you and falls over your shoulder there is just as much light upon your book or paper and yet the eyes are spared the brightness.

Never read while lying upon the back. You cannot read comfortably in this position and you have to strain the eyes so that it is very tiring. If for any reason you must read lying down, do so with the shoulders and head raised into a half-sitting position.

There may be some excuse for business men's *reading in the cars*, for often this may be the only time they have to read the daily papers. But there is no reason why children should do this. It is injurious, in the first place, because the light is usually poor, but chiefly, because the constant jolting of the car makes the page unsteady and requires a constant strain upon the eyes to keep the place.

Never wash your eyes with water which another person has used on his face. Never use a *towel* for wiping your face, which another person has had to his face, unless this person is one of your family and you know he has no eye disease. There is a disease of the eyelids, called *granular lids*, which is very contagious; many children contract it in school by using the towel which another child who had the disease has used.

Do not stoop when you read, but raise the book so that you can hold the head erect.

Weak Sight.—Some persons are born with weak eyes —that is, they do not see so well as other people and have to wear glasses. Some of these people are called *near-sighted*, others are called *far-sighted*. If the doctor advises you to wear

glasses you should not be ashamed to do so. Only vain persons object to wearing glasses when they are necessary.

Old Sight.—After persons are about forty years old they can still see distant objects well ; but they need glasses in looking at near objects.

Effects of Alcohol and Tobacco on the Sight.—Both alcohol and tobacco have a bad effect upon the eyesight. Just how much harm is done by each in any individual case is difficult to determine since most men who drink also use tobacco. The smoke of tobacco has an irritating effect on the lining membranes of the eye, and produces inflammation. Alcohol has the power to congest the blood-vessels ; at the same time it makes the eyes water and renders them blood-shot. A man who drinks and smokes much has unsteady vision, just as he has an unsteady hand. He cannot aim straight in shooting, cannot measure distances accurately with his eyes, and often makes missteps in consequence. His vision is less accurate and acute, and a drinking man is rarely employed in any position where quickness and accuracy of vision is needed, as in train service where signals are to be read. A peculiar effect of alcohol and tobacco upon the eyes is that floating things, flying objects, lines and figures appear before the eyes, recurring with persistency, or the image of an object will remain on the retina for a long time after one has stopped looking at it, even after the eyes have been closed.

The peculiar delusions of sight in delirium tremens, when a man sees reptiles and vermin and all sorts of weird and horrible sights, are due to the action of the alcohol on the centres of sight in the brain.

Cases of acute alcoholism and chronic alcoholism as well as excessive smoking are often accompanied by periodic attacks of blindness. This is due to the effect that alcohol has on the optic nerve, causing it to degenerate so that no image can be carried from the retina to the brain. Whether this severe disease of the optic nerve takes place or not, the fact is

true that a man who smokes and drinks much usually has poor eyesight and suffers from trouble with his eyes.

SYNOPSIS.

The Eye:

1. Protections.
   - *a.* Surrounded by bony orbit.
   - *b.* Rests on cushion of fat.
   - *c.* Eyebrows—Keep off perspiration.
   - *d.* Eyelids. } Keep out dirt, light, and perspiration.
   - *e.* Eyelashes. }
2. Parts:
   - *a.* Coats:
     1. Opaque part behind.
        - *a.* Sclerotic—Outer, white, dense.
        - *b.* Choroid—Middle, colored, brown.
        - *c.* Retina—Inner, composed of nerve-tissue.
     2. Transparent part in front—Cornea.
   - *b.* Iris—Curtain to keep out light; in centre is
   - *c.* Pupil—Size changes.
   - *d.* Lens.
   - *e.* Fluids:
     1. Aqueous humor.
     2. Vitreous humor.
   - *f.* Muscles—Six small ones attached to eye, to move it in all directions.
   - *g.* Nerve—Attached behind and passing to brain, with which we really see.
   - *h.* Lachrymal gland—Near the eye, gives off the tears, which keep the eyeball moist, collected by tear-sac and escape by tear-duct into nose.

Care of the Eye:

1. Requires rest when used for long time.
2. Good light in reading.
3. Injurious to read very fine print.

4. Light should come from behind—over shoulder.
5. Not well to read while lying down.
6. Not well to read while riding in cars.
7. Risk of contracting eye disease in using towels or water that other people have used, to eyes.
8. In reading, sit erect.
9. Weak sight requires glasses.
10. Old sight (after forty) requires glasses.

QUESTIONS.

1. In what are the eyes placed? 2. How are the eyes protected? 3. What do the eyelids do? 4. Of what use are the eyebrows and eyelashes? 5. Why should we not cut the eyelashes or the eyebrows? 6. What is the shape of the eye? 7. What is the cornea? 8. How many layers has the back part of the eye? 9. What is the back part called? 10. Which is the most important of these three layers? 11. What is the pupil? 12. What is the iris? 13. What is the lens? 14. With what is the interior of the eye filled? 15. What two fluids do we have in the eye? 16. Is the pupil always of the same size? 17. When does it become large? 18. When does it become small? 19. Of what use is the pupil? 20. How many muscles are there to each eye? 21. Of what use are these muscles? 22. What is the cause of cross-eyes? 23. With what part of the body do we really see, the eye or the brain? 24. How is this proven? 25. What instrument may our eye be compared with? 26. Explain in what ways our eye resembles the photographer's box? 27. Where is the nerve of the eye? 28. What does it do? 29. What do we mean by an image? 30. How is the eye kept moist? 31. Where is the body which produces the tears? 32. What is it called? 33. How are the tears collected again? 34. What becomes of them? 35. Where is the tear-sac? 36. Where is the tear-duct? 37. What causes the tears to flow more than usual? 38. Why should we stop after we have read a long time? 39. What does a tired feeling or pain in the eye after reading mean? 40. What sort of light should be avoided? 41. Where should the light come from when you read? 42. Should it come from the front? 43. Why not? 44. Can a person read lying down, without injury to his eyes? 45. Why not? 46. Why should we not read on the

cars. 47. Why should we not use towels that other persons have used to their faces? 48. What disease of the eyelids may be contracted in this way? 49. What position should you take when you read? 50. What is meant by weak sight? 51. After what age do people need glasses for reading?

THE EAR—THE SENSE OF HEARING.

Like the eye, the ear is an organ which adds very much to our comfort, pleasure, and knowledge.

Parts of the Ear.—The ear is divided into three parts: An *outer*, a *middle*, and an *inner*.

The Outer Ear is the part seen at the side of the head. It is expanded and *formed of gristle*, covered with skin. Its shape is not only ornamental, but useful, for it serves to collect the sound and lead it into the deeper parts of the ear. As a rule, we cannot move the ears; but in the lower animals the ear can be moved in all directions, and in this way these animals tell where the sound comes from. From this outer part of the ear there is a *canal* about an inch long which leads to the next part, or the *middle ear*. In this canal is usually found a little yellowish substance, which we call *ear-wax*, which serves to keep the canal soft and moist and to keep out insects, which dislike this wax.

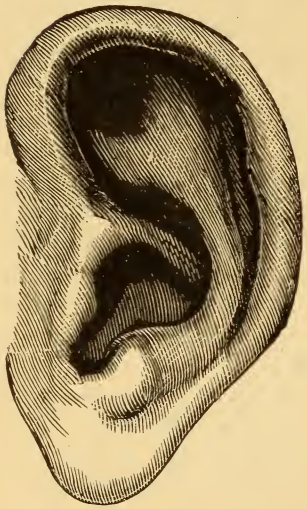


FIG. 97.—The Outer Ear.

The Middle Ear.—The middle part of the ear contains the *drum*, and is only about half an inch across. It is at the

bottom of the canal which leads from the outer ear. Between the two a sheet of membrane is stretched which is called the *drum-membrane.* In the middle ear itself there is nothing but three small *bones* which are joined so as to form a small chain. One end of this chain is fastened to the drum-membrane and the other to the inner ear, so that these bones connect the outer ear with the inner ear.

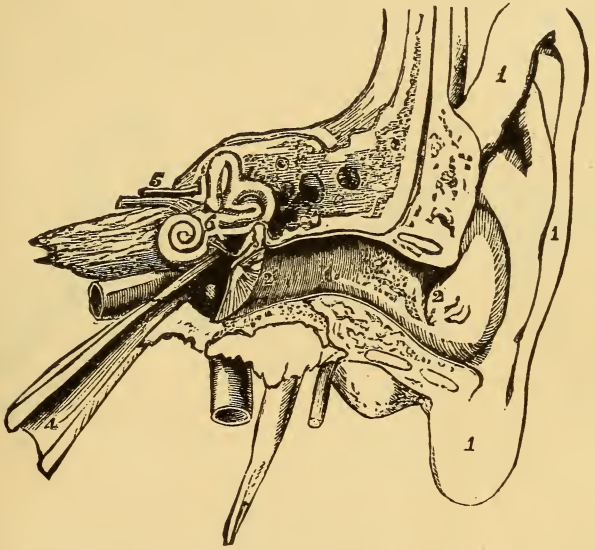


FIG. 98.—The Different Parts of the Organ of Hearing. 1, The outer ear; 2, the canal leading from the outer to the middle ear; 3, middle ear; 4, Eustachian tube; 5, nerve of hearing; 6, the internal ear.

Bones of the Ear.—These bones are shown in Fig. 99, and are very interesting. They are named, according to their shape, the hammer, the anvil, and the stirrup.

Connection Between the Ear and the Throat.—Perhaps you may have noticed that sometimes when you blow your nose hard there is a stuffed feeling in the ears; or that when your throat was sore your ears were also affected. Sometimes, too, when you swallow you feel something in your

ear. This is because there is a tube which runs from the throat to the middle ear. It is very important that this tube remain open, for otherwise air cannot enter the middle ear as it should and we do not hear well. This tube is called the *Eustachian tube*, after the physician who first described it (Fig. 98, 4).

The Internal Ear.—This part of the ear is placed very deeply in the bone. There are several circular canals and a winding passage like a staircase hollowed out of the bone, and in these the inner ear is contained (Fig. 100). In these circular canals we find a delicate membrane and a fluid on

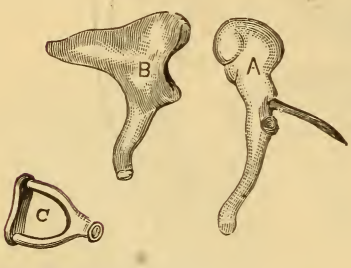


FIG. 99.—The Small Bones of the Ear. A, The hammer; B, the anvil; C, the stirrup.

FIG. 100.—The Internal Ear.

each side of it. The arrangements in the internal ear are very intricate.

The Nerve of Hearing.—The nerve of hearing is attached to the internal ear and from this part it passes to the brain (Fig. 98, 5); it therefore conducts the sound to the brain just as the optic nerve conducts sight to the brain.

Sound.—Before studying how we hear, it is necessary to understand *how sound is produced.* Sound is produced whenever the air is made to *vibrate*—that is, whenever the air is put into motion resembling waves. You will understand this better if you think for a moment of the water: Suppose when a pond is quiet, you throw in a stone; this causes a mo-

tion in the water and you will then see rings start out from the point where the stone fell, these rings becoming larger and larger until they are finally lost; but all the time these rings or very small waves have been going farther and farther from the centre. Now imagine the same thing occurring in the air. If you strike a bell, for instance, you know that the bell is vibrating, because if you put your finger on it you can feel this motion. This motion is given to the air, and the air vibrates in the same way, except that the vibrations travel through the air to our ear.

Solids conduct sound even better than air does; if you place your ear at one end of the table and strike the other end the sound which you hear will be very loud.

How We Hear.—Now that we know what sound is, let us study how we hear. The waves of sound pass through the air and reach the *outer ear*, which is shaped so as to collect them and lead them into the canal to the *drum-membrane*. The waves of sound beat against this membrane and cause it to vibrate; when this membrane vibrates, the *bones of the middle ear* must also move to and fro, because they are attached to it. The bones of the middle ear carry the vibrations to the *internal ear*, where the nerve of hearing ends in a large number of fine hairs, and these carry the sound to the *brain*.

Deaf-Mutes.—Persons who cannot hear when they are children, and therefore cannot imitate sounds from other people, are called *deaf-mutes*. These unfortunate people have voices just like others; but they cannot hear the sounds, and therefore they cannot speak in the ordinary way. But they can make themselves understood in two ways: One way is by means of signs and letters which they make with their *fingers*, and which they learn to do very rapidly. The second method, and the most recent, is to teach the deaf-mutes to talk by having them imitate the motion of our *lips*. It is surprising how well they learn to do this; some of them being able to carry

on a conversation and yet not hear what is spoken, but understanding it by watching the movement of the lips.

Care of the Ears.—We should never *try to pick out the wax* in the ears with hairpins and other sharp instruments. A little wax is quite natural, and if too much is there it is best to let the doctor remove it, for we may injure the delicate parts of the ear.

If *water* gets into the ear during bathing, hold the head over to one side and pull the outer ear up and down gently, and it will flow out.

If an *insect* should crawl into the ear, a little soap and water will kill it, and at the same time bring it out.

A *blow* upon the side of the head or over the ear is dangerous, because it sometimes affects the brain; it may also tear the delicate drum-membrane and thus interfere with good hearing.

The ears do not need to be washed out when they are healthy; simply *wash the outer ear* and do not meddle with any of the deeper parts.

Effects of Alcohol on the Hearing.—The effects of alcohol on the ear are still very imperfectly understood. It is probable, however, that, like the other sensory nerves of the body, the acoustic nerve undergoes some modification similar to that seen in the optic nerve when it is poisoned by alcohol. In such a case deafness would be produced. While sudden deafness from the effects of alcoholic drinks may be considered a rare condition, it is by no means infrequent that by the use of such drinks chronic congestion of the delicate structures of the ear is produced, which causes or aggravates a catarrh of the middle ear which ultimately results in impaired hearing, if not in deafness. Chronic catarrhal disease of the middle ear is a very frequent disease in large cities where there is so much irritating dust, that constantly inflames the nose and the pharynx. This inflammation usually extends up the Eustachian tubes, and produces the sensations

of buzzing and ringing in the ears. In such conditions the bad effects of alcohol are positive, and tend to make the disease progress at a much quicker rate than under the usual circumstances.

In delirium tremens hallucinations of hearing are very frequent; the patient in the delirium not only sees things but may hear a vast variety of sounds, people shouting to him or whistles blowing or shrieks of despair. These are produced by the action of the poison on the brain centres for hearing, just as in the case of the hallucinations of sight. The place in the brain that is affected is in the occipital lobes or just "in the back of the head."

SYNOPSIS.

The Ear:

Parts:

1. Outer ear—Collects sound.
2. Canal leading from outer to middle ear.
3. Middle ear:
   a. Drum-membrane.
   b. Bones: (1) Hammer, (2) anvil, (3) stirrup.
4. Internal ear—Nerve of hearing ends here in fine hairs, and conveys sound to brain.
5. Eustachian tube—Leading from throat to middle ear.

How we Hear.

1. Vibration of sounding body.
2. Vibration of air.
3. Collection of sound by outer ear.
4. Conveyance of sound by canal.
5. Strikes against drum-membrane.
6. Vibrations conducted by chain of bones to
7. Internal ear, where they strike the hair-like ends of
8. The nerve of hearing, which conducts sound to
9. Brain.

QUESTIONS.

1. Into what three parts can the ear be divided? 2. Why is the external ear shaped as it is? 3. Can the lower animals move their ears? 4. Of what use is this to them? 5. What leads from the outer ear to the middle ear? 6. What is ear-wax? 7. What are its uses? 8. What is another name for the middle ear? 9. Where is the drum-membrane? 10. What is in the middle ear? 11. How are the bones of the middle ear arranged? 12. What are the names given to the bones of the middle ear? 13. What connects the throat with the middle ear? 14. Where is the internal ear? 15. What is its form? 16. What is the internal ear? 17. Where is the nerve of hearing? 18. What does it do? 19. How is sound produced? 20. What conducts the sound? 21. Can solids conduct sound? 22. How can you prove this? 23. Explain how we hear? 24. What is meant by a deaf-mute? 25. Has a deaf-mute any voice? 26. Why cannot he talk without special teaching? 27. How do deaf-mutes make themselves understood? 28. Why should we not try to pick out the wax in our ears? 29. How would you get rid of any insect that crawled into the ear? 30. Why is a blow upon the side of the head or over the ear dangerous? 31. What is the effect of alcohol on the hearing?

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A TEXT-BOOK

ON

PHYSICS

BEING A SHORT AND COMPLETE COURSE

BASED UPON THE LARGER WORK OF GANOT.

For the Use of Academies High Schools, etc.

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